DECEMBER, 1949

PETROLEUM REFINER

SPECIALIZED FOR REFINING, NATURAL GASOLINE, AND PETRO-CHEMICAL ENGINEERING, OPERATION AND MANAGEMENT

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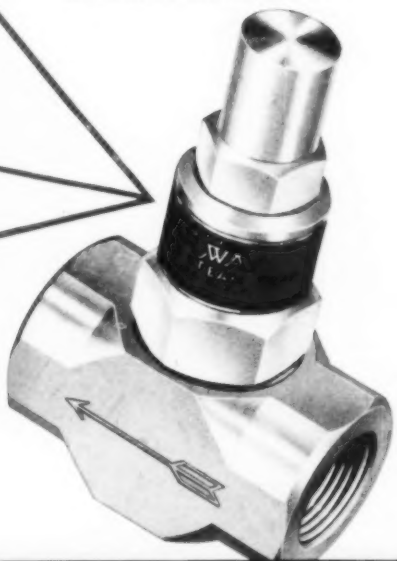
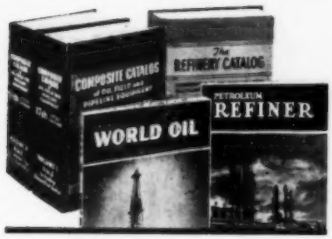
Yarway Traps beat the worst weather in this installation at Thermoid's Trenton plant.



YARWAY IMPULSE STEAM TRAP



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Annual Index—
Petroleum Refiner follows its practice of presenting in this, the final issue of 1949, the Annual Index for its twelve 1949 numbers. This handy, on-the-spot reference starts opposite page 160.

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PETROLEUM
REFINER

Specialized for Refining, Natural Gasoline and Petrochemical Engineering, Operation and Management

R. L. DUDLEY, President **A. L. BURNS, General Manager**

VOLUME 28, NO. 12 **DECEMBER, 1949**

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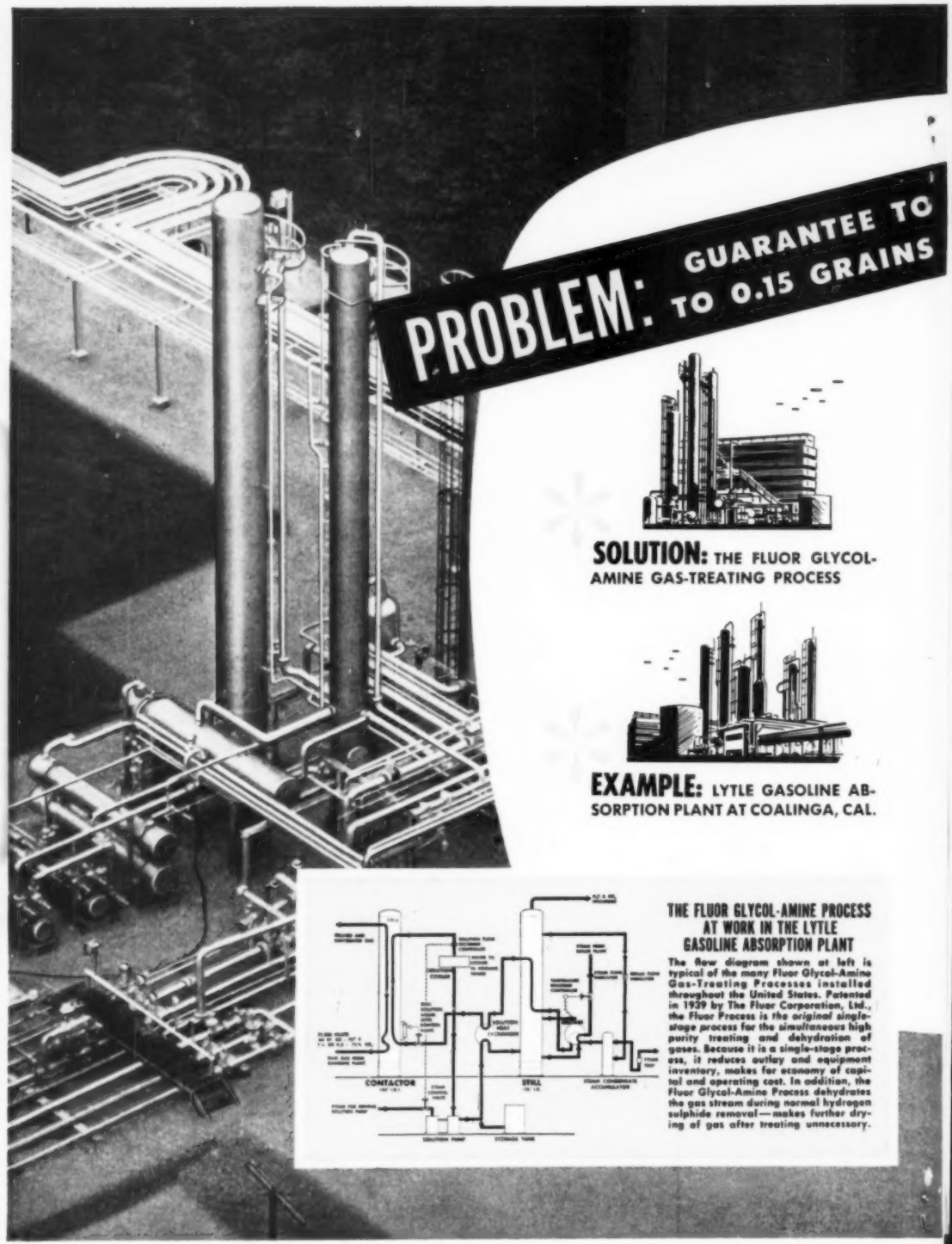

PROBLEM: GUARANTEE TO TO 0.15 GRAINS

SOLUTION: THE FLUOR GLYCOL-AMINE GAS-TREATING PROCESS

EXAMPLE: LYTLE GASOLINE ABSORPTION PLANT AT COALINGA, CAL.

THE FLUOR GLYCOL-AMINE PROCESS AT WORK IN THE LYTLE GASOLINE ABSORPTION PLANT

The flow diagram shown at left is typical of the many Fluor Glycol-Amine Gas-Treating Processes installed throughout the United States. Patented in 1939 by The Fluor Corporation, Ltd., the Fluor Process is the *original single-stage process* for the *simultaneous* high purity treating and dehydration of gases. Because it is a single-stage process, it reduces outlay and equipment inventory, makes for economy of capital and operating cost. In addition, the Fluor Glycol-Amine Process dehydrates the gas stream during normal hydrogen sulphide removal—makes further drying of gas after treating unnecessary.

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The Lytle Gasoline Absorption Plant at Coalinga, California, is a story of the Fluor Glycol-Amine Gas-Treating Process at work.

Expansion of natural gas supply through deeper drilling introduced into the Lytle Plant a natural gas so high in hydrogen sulphide content that it was no longer acceptable as commercial sales gas. After processing for gasoline recovery, the discharge gas was analyzed and found to contain 1.25 grains of hydrogen sulphide per 100 SCF and up to three-fourths of 1 mol per cent of carbon dioxide. Even though this gas was sufficiently pure for sale in many areas, in this particular instance requirements for commercial gas were set to *not more than 0.15 grains of hydrogen sulphide per 100 SCF* . . . a purity requirement so stringent that it would only be attempted by Fluor Gas Processing Engineers using the Fluor Glycol-Amine Gas-Treating Process.

Following study of the requirement by Fluor, a Research Department pilot plant was set to run at gas composition and operating conditions simulating those at the Lytle Plant. Here it was *proved* the Fluor Glycol-Amine Gas-Treating Process could meet—*and exceed by a comfortable operating margin*—the 0.15 grain per 100 SCF requirement efficiently, economically, and on a guaranteed basis.

The plant for the Lytle job was then designed on the findings of the Fluor Research Department. Engineering was set in motion, and a field construction schedule formulated.

The Lytle unit is a "sweet"-running unit paralleling laboratory and pilot plant findings—meeting its guaranteed performance with an adequate margin. This new installation raises the total installed capacity of Fluor Glycol-Amine Gas-Treating Plants to 585,000,000 SCF/D.

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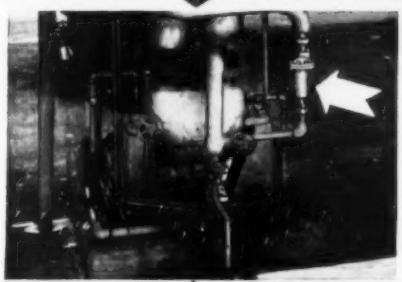

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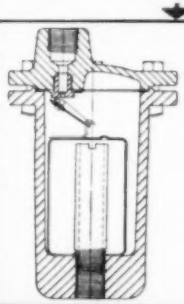

Cross section of an Armstrong No. 3211 forged steel trap. Forged cap and body, compressed graphited asbestos gasket, all stainless mechanism. This trap will take high temperature and shock without danger of fracture.

SMALL SIZE . . . LIGHT WEIGHT

NOW, for many applications, refineries and natural gasoline plants can have the additional safety of a forged steel steam trap for only a few dollars more than a cast iron trap of comparable size. The Armstrong No. 3211 trap illustrated will withstand fire or explosion without danger of fracture. It is the baby of the Armstrong forged steel line, a low priced trap for working pressures up to 250 psi; design pressure, 450 psi. Capacity range 750 to 1000 lbs/hr continuous. ½" or ¾" pipe connections. Diameter 4¼"; height 7"; weight 8 lbs. This trap is a natural for refinery and natural gasoline plant service.

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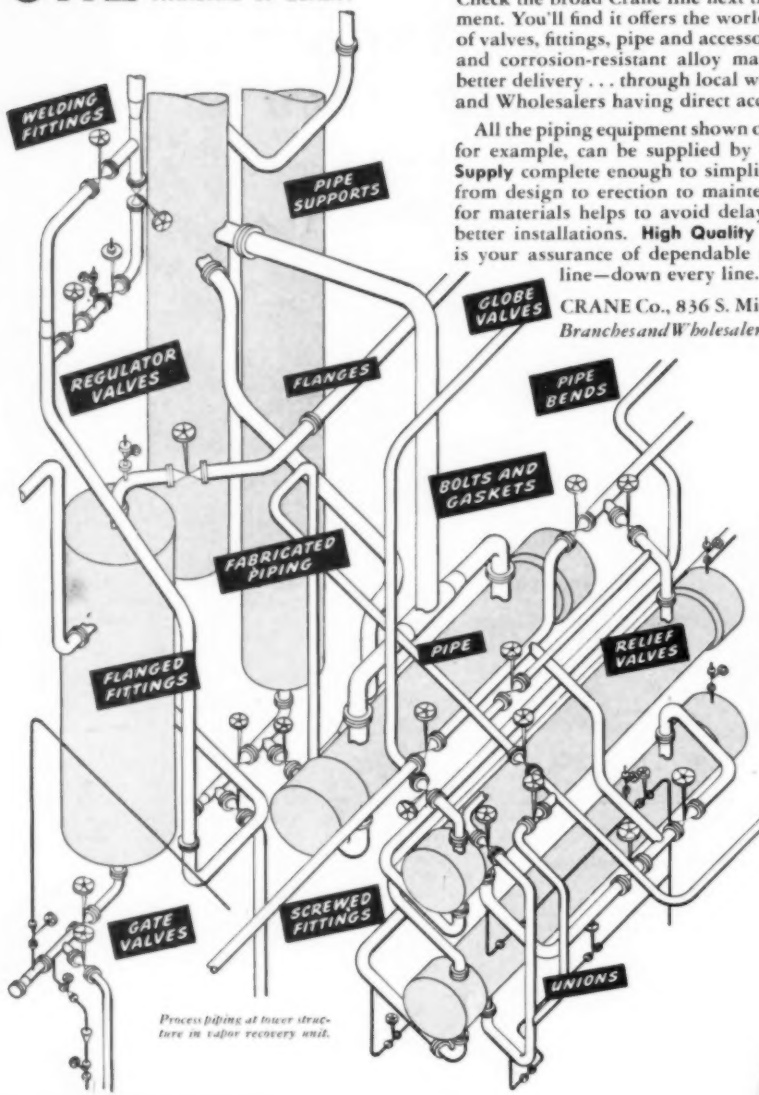
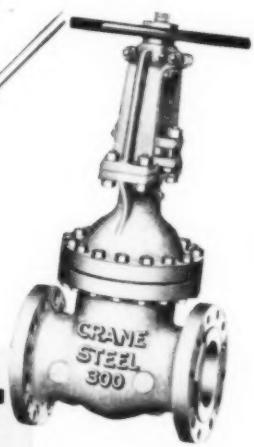


Process piping at lower structure in vapor recovery unit.

FOR PETROLEUM PROCESSING —*Crane recommends No. 33X 300-Pound Cast Steel Wedge Gate Valves. One of a complete line of steel valves trimmed to handle oil and oil vapor at temperatures up to 1000 deg. F. Crane steel gates, globes, angles, and checks are available in pressure classes from 150 to 1500 pounds. Flanged, screwed, or welding ends. See your new Crane Catalog, p. 223.*



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automatic compensation

for pressure

for temperature

for pressure and temperature

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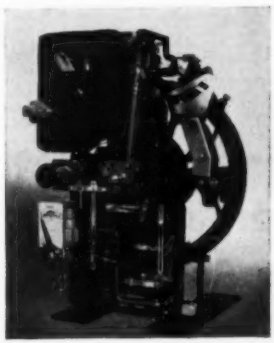
Detailed information on these meters is contained in our new bulletin "Here's How Hagan Ring Balance Meters Provide *Automatic* Compensation for Pressure, for Temperature, for Pressure *and* Temperature." To get your copy, just fill out the coupon below, or write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.



Front view (chart removed) of Hagan Pressure-Compensated Ring Balance Meter. This particular model is equipped with three pens, indicating uncorrected flow on a strip indicator (not shown), and recording pressure and corrected flow. Corrected flow is continuously totalized by the integrator (upper left).

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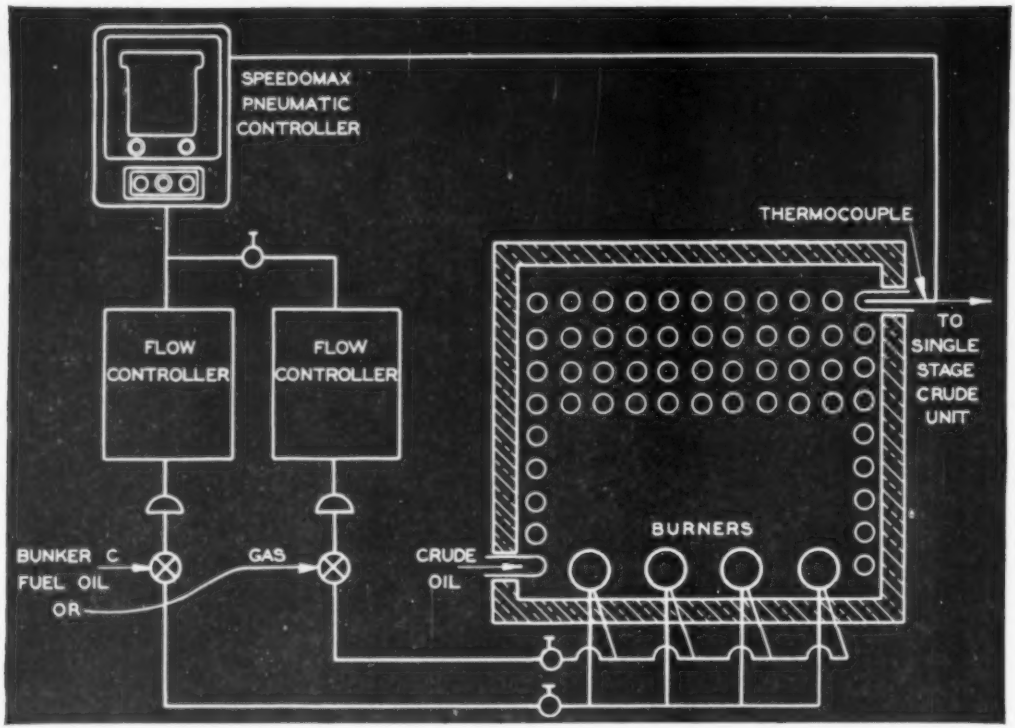

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"Well, there's a bad time lag. The stock takes several minutes to go through the furnace, from the fuel valve at the inlet to the outlet, where the thermocouple is located. Also, we burn either gas or oil—whatever fuel we have the most of, so that the fuel quality varies all over the lot."

"Another headache," he continued, "is charging stock. From day to day we charge whatever the tankers bring us. And each stock has its own characteristics, so that we must have different charging pressures and changes in furnace temperature. The whole ball of wax adds up to a real test for any temperature control."

The L&N man nodded. "Fair enough," he said. "Speedomax Pneumatic Control takes the tough jobs right in its stride. The same features of complete control that make it your best buy for your every-day control jobs will handle the toughest ones. That's the beauty of Speedomax Pneumatic—you can move it from any job to any other. You can standardize on it. Try it here and see!"

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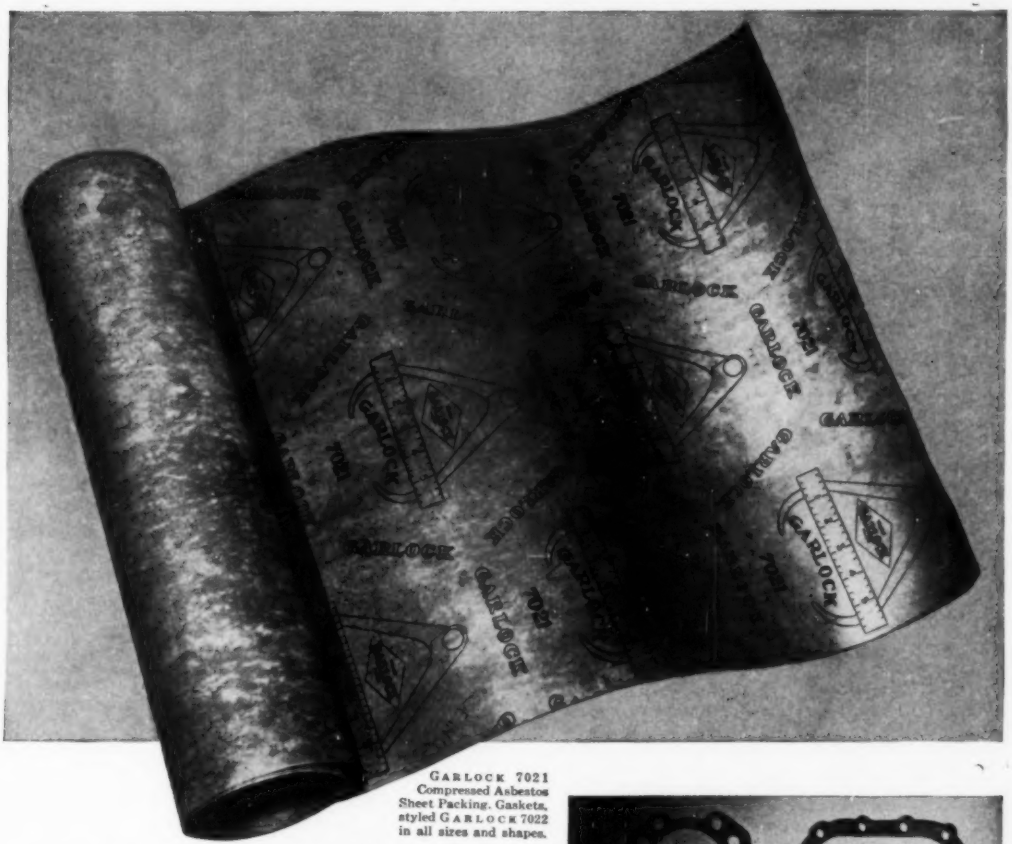

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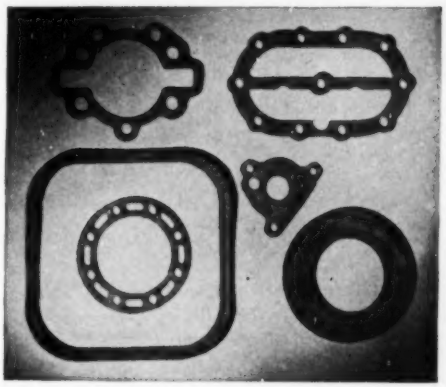

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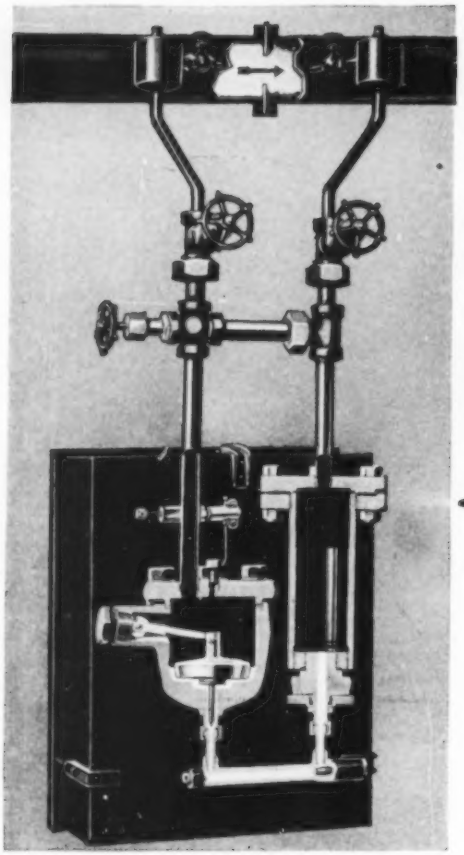

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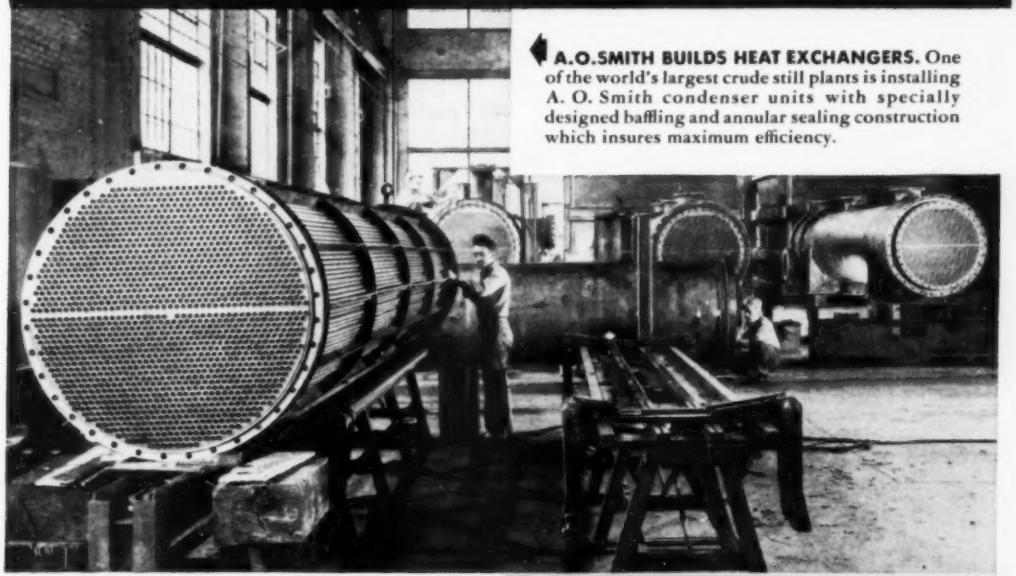
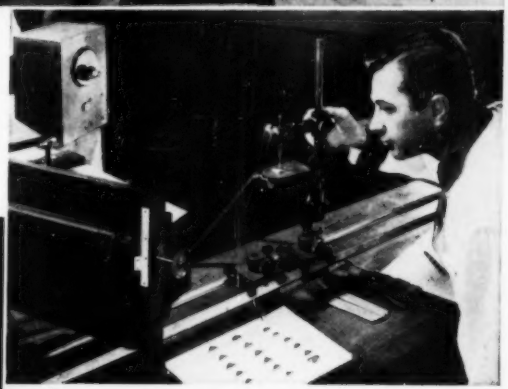
International Division: Milwaukee 1

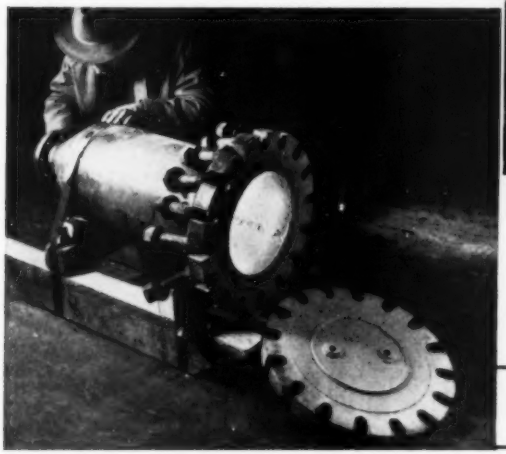


A.O.SMITH BUILDS HEAT EXCHANGERS. One of the world's largest crude still plants is installing A. O. Smith condenser units with specially designed baffling and annular sealing construction which insures maximum efficiency.

NO PIG-IN-A-POKE HERE. The customer and A. O. Smith collaborated in the building of this SMITHway alloy-lined experimental pilot unit so that the alloy lining, selected by laboratory tests for corrosion service, could be subjected to process test-runs before the full-size production units were manufactured.



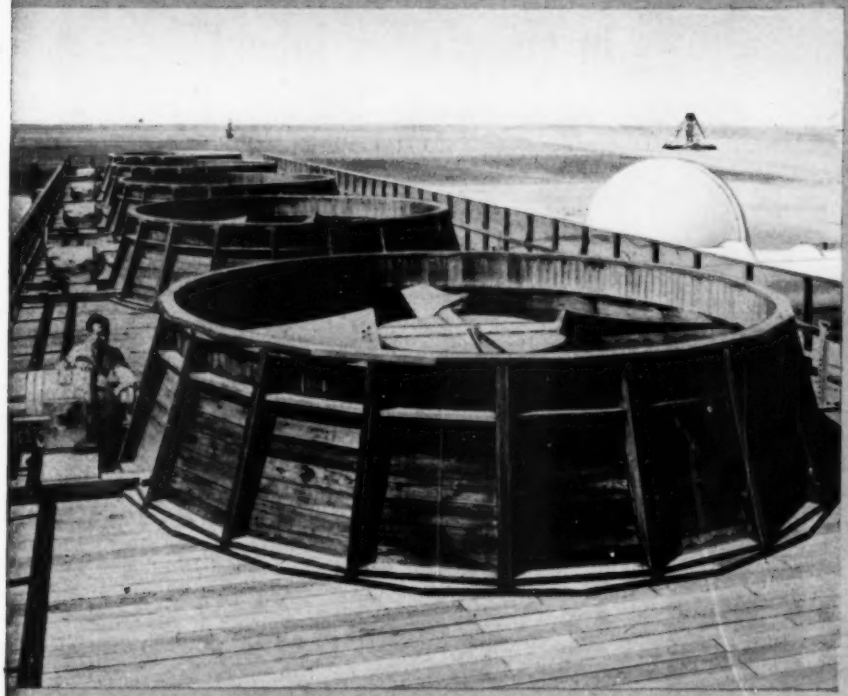
SAFEGUARDING THE CUSTOMER'S INVESTMENT. After the selection of the alloy lining, A. O. Smith makes doubly sure that it conforms to specifications, and does not contain any undesirable residual elements, by spectro-chemically analyzing sample coupons of the lining before releasing it for manufacture into the vessel.



VESSEL BULLETINS. Write the nearest A. O. Smith office listed above for Bulletin V-46, SMITHway Vessels, Alloy, Alloy-Lined, Clad, and Glass-Lined; Bulletin V-44, Field Assembly of Pressure Vessels.

FOSTER WHEELER COOLING TOWERS

on many landscapes—in many climates



The cooling tower shown here serves the high speed engines operating the 6 by 6 foot supersonic wind tunnel of the NACA's Ames Aeronautical Laboratory at Moffet Field, California. It is an induced draft type of tower which was designed by Foster Wheeler engineers for high efficiency in cooling. The flexibility of this design, now standardized, enables Foster Wheeler to engineer and erect cooling towers for the requirements of any load anywhere in the world.

FOSTER WHEELER CORPORATION
165 Broadway • New York 6, New York.

FOSTER WHEELER

FLARE STACK at the plant of a large Ohio refiner. Its Inconel flare tip, installed 3 years ago, has already lasted 8 times as long as tips previously used, has saved $4,400 a year in steeplejack labor charges. (Above) Close-up view of the corrosion-resistant, heat-resistant Inconel tip.

HERE'S THE TIP

that saved a refinery $13,200 in steeplejack labor!

In three years, a large Ohio refinery has saved $13,200 in steeplejack charges.

The story is told here for the first time...

Until 1946, the average life of a flare tip on the main stack at this plant was six months. By that time, the tip was ready to be taken down and replaced – at a cost of $2,200 for steeplejack labor alone!

Too much, agreed engineers, so they started looking for flare tips that would last longer. **As a result of their experimentation, steeplejack labor for flare tip maintenance and replacement on this stack has not cost a cent since 1946.**

What happened? They had a flare tip built of heat-resistant, corrosion-resistant INCONEL*. To date, it has delivered *six times the service* of the best flare tip previously used – and it's still on top of the stack, still holding out against corrosive gases, soot deposits and high temperatures.

INCONEL is regarded as one of the outstanding alloys for withstanding red-heat temperatures without scaling or cracking. Like all INCO Nickel Alloys, it has remarkable resistance to corrosion. In addition, it can be cut, bent, formed, machined and welded by ordinary shop methods. Welds are as resistant to heat and corrosion as INCONEL itself.

So think of INCONEL for refinery applications that demand a metal with exceptional resistance to corrosion and high temperatures. **And remember to turn some of your problems over to our Technical Service.** These men know what has been done (and what is being done) to provide durable metals for your kind of work.

EMBLEM OF SERVICE INCO TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

*Reg. U. S. Pat. Off.

INCONEL*...Your Partner in Progress

STAINLESS
TUBING
IS YOUR BEST BUY
for highly
CORROSIVE
conditions
B&W
makes ANY TYPE you need -- SEAMLESS & WELDED
ALL THESE . . . AND MORE
Croloy 18-8 Hi Carbon (Type 302)
Croloy 18-8 Si (Type 302B Mod.)
Croloy 17-8 FM (Type 303 Mod.)
Croloy 18-8 S (Type 304)
Croloy 20-10 (Type 308)
Croloy 25-12 (Type 309S)
Croloy 25-12 Cb (Type 309S Cb)
Croloy 25-20 (Type 310)
Croloy 16-13-3 (Type 316)
Croloy 16-13-3 Cb (Type 316 Cb)
Croloy 18-13-3 (Type 317)
Croloy 18-8 Ti (Type 321)
Croloy 12 Al (Type 405)
Croloy 12 (Type 410)
Croloy 12-2 (Type 414)
Croloy 13 (Type 420)
Croloy 18 (Type 430)
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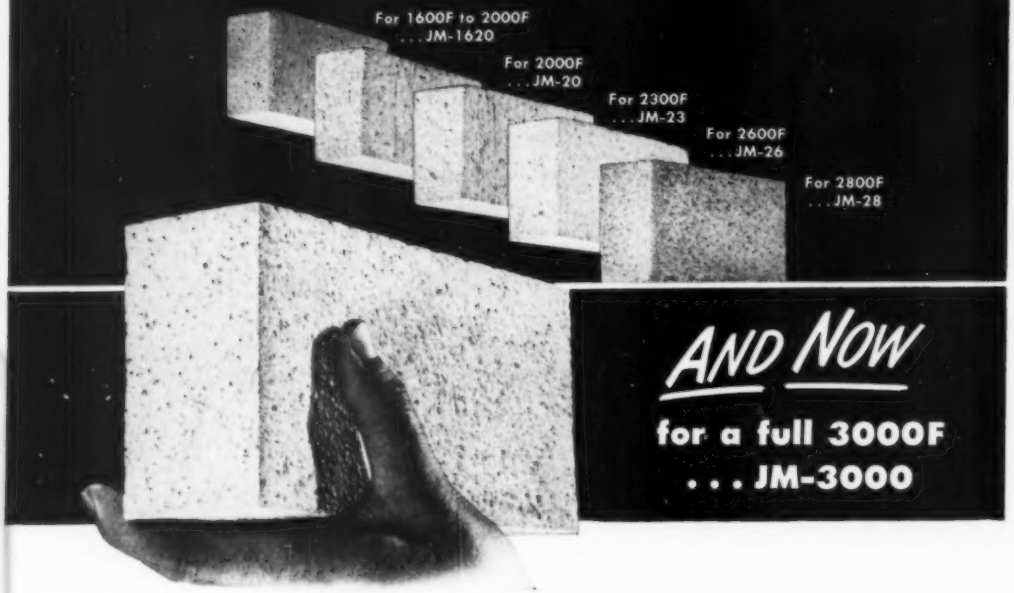
Croloy 27 (Type 446)
B&W
SEAMLESS and WELDED
TUBES
THE BABCOCK & WILCOX TUBE COMPANY

MEET the family of Johns-Manville Insulating Fire Brick . .



AND NOW for a full 3000F . . . JM-3000

HERE IS AN OUTSTANDING FAMILY of insulating fire brick for back-up or exposed use . . . the only family of its kind . . . that gives you a complete range . . . a *quick heating* insulating fire brick for every purpose.

By taking advantage of the quick heating characteristics of these insulating fire brick, you'll benefit through important savings in fuel because of the quicker rise to proper operating temperature in the furnace. This is a result of the low heat storage capacity and low thermal conductivity characteristics of the brick. These factors are especially important where furnaces are being intermittently operated.

The same materials can also be obtained in large size units as Johns-Manville Insulating Fireblok. This product has many advantages over the smaller size fire brick, from both a construction and stability standpoint. They can be quickly applied because they are easy to cut and fit. J-M Insulating Fireblok provide additional heat savings because they reduce the number of joints, and require less mortar for bonding.

Why not have a Johns-Manville insulation expert call to tell you more about ways in which you can save by using these insulations in your furnaces. Write Johns-Manville, Box 290, New York 16, N. Y. for further information.

	JM-1620	JM-20	JM-23	JM-26	JM-28	JM-3000
Densities, lb per cu ft	29	33	42	48	58	63-67
Transverse Strengths, psi	60	80	120	125	120	200
Cold Crushing Strengths, psi	70	115	170	190	150	400
Linear Shrinkage,† percent	0.0 at 2000 F	0.0 at 2000 F	0.3 at 2300 F	1.0 at 2600 F	4.0 at 2800 F	0.8 at 3000 F
Reversible Thermal Expansion, percent	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F
Conductivity* at Mean Temperatures						
500 F	0.77	0.97	1.51	1.92	2.00	3.10
1000 F	1.02	1.22	1.91	2.22	2.50	3.20
1500 F	1.27	1.47	2.31	2.52	3.00	3.35
2000 F	—	1.72	2.70	2.82	3.50	3.60
Recommended Service						
Back up	2000 F	2000 F	2300 F	2600 F	2800 F	3000 F
Exposed	1600 F	2000 F	2300 F	2600 F	2800 F	3000 F

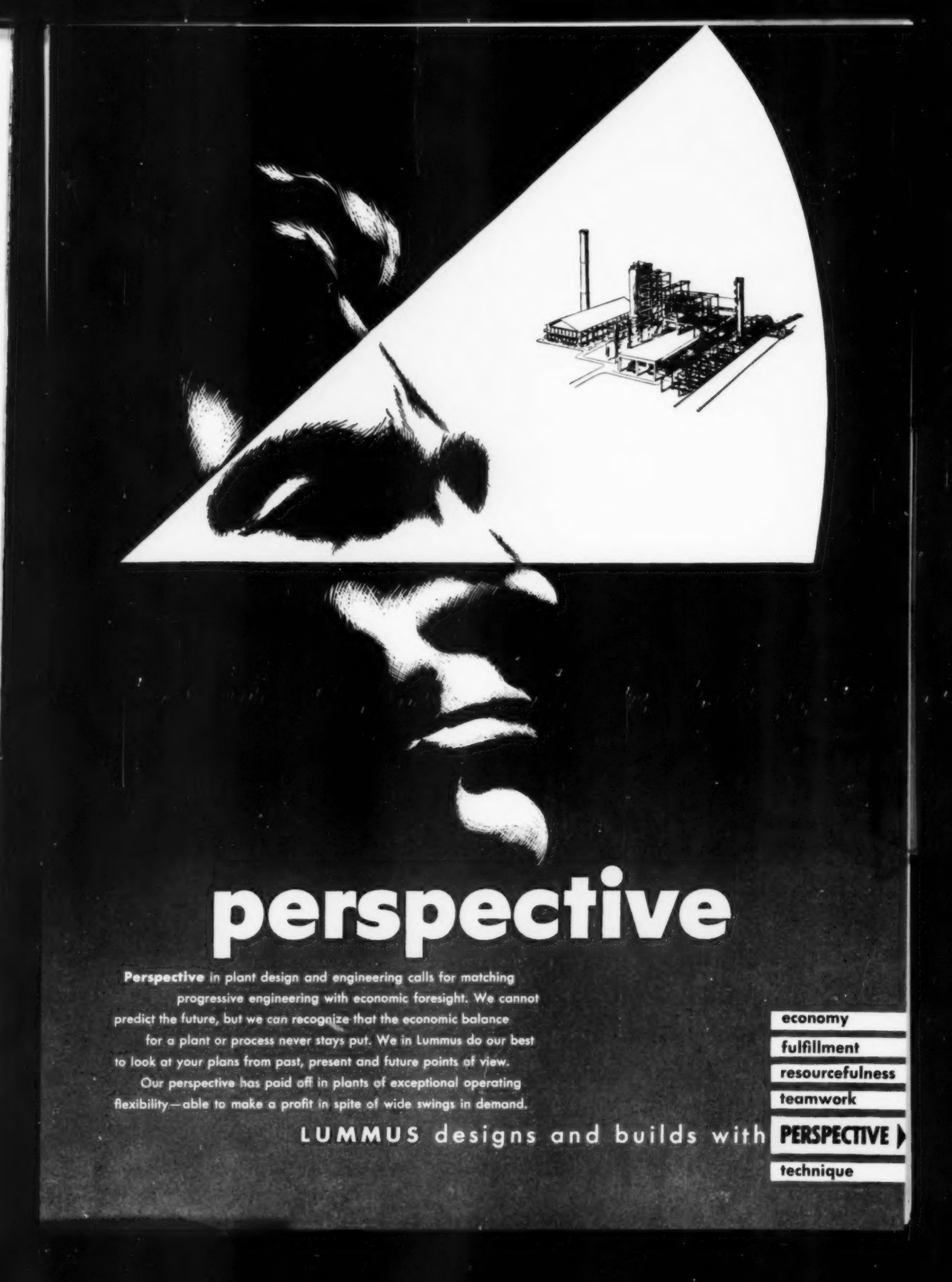
† 24-hr simulative service panel test for JM-3000; 24-hr soaking period for other brick.

* Conductivity is expressed in Btu in. per sq ft per F per hour at the designated mean temperatures.

Note: Above tests are in accordance with A.S.T.M. tentative standards.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville First in INSULATIONS



perspective

Perspective in plant design and engineering calls for matching progressive engineering with economic foresight. We cannot predict the future, but we can recognize that the economic balance for a plant or process never stays put. We in Lummus do our best to look at your plans from past, present and future points of view.

Our perspective has paid off in plants of exceptional operating flexibility—able to make a profit in spite of wide swings in demand.

LUMMUS designs and builds with **PERSPECTIVE**

- economy
- fulfillment
- resourcefulness
- teamwork
- technique

perspective

In planning this French refinery, both its initial operating level and its ultimate, expanded capacity were guiding factors for design. Room was provided for the easy addition of filters, double pipe chillers and refrigeration equipment, to double the capacity of the unit in this respect. An efficient plant today, it will be equally efficient tomorrow, because expansion need never be "makeshift."

perspective

Lummus catalytic cracking plants, war-built for 100-octane gasoline, are being operated to produce motor gasoline of lower octane rating on a consistent low-cost basis. Their suitability for this latter service was attained without any compromise in design for their original purpose. Rather, the Lummus-engineered design had the flexibility to meet requirements for the efficient production of either fuel.

perspective

The interest of Lummus in any of its installations does not end with construction and initial operation for customer acceptance. Periodic visits by Lummus field representatives are continued to review performance. In a recent case where a radical change in product requirements arose, these operating checkups furnished valuable aid in arriving at a prompt and practical plant modification to meet the new demands.

THE LUMMUS COMPANY
420 Lexington Avenue, New York 17, N. Y.

LUMMUS

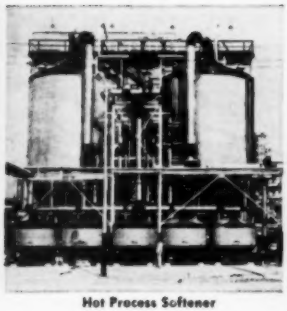
CHICAGO—600 South Michigan Avenue, Chicago 5, Ill.
HOUSTON—Mellie Esperson Bldg., Houston 2, Texas

The Lummus Company, Ltd., 525 Oxford St., London, W-1, England

Société Française des Techniques Lummus
39 Rue Cambon, Paris 1er, France

Compañía Anónima Venezolana Lummus—Edificio "Las Gradillas"
Esquina Las Gradillas, Caracas, Venezuela

Zeolite Softener



Hot Process Softener

Deaerating Heater

GRAVER

WATER CONDITIONING EQUIPMENT

IS

Accurately Engineered

to individual plant requirements

Backed By 40 Years of Experience

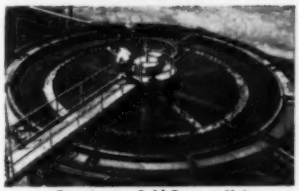
in design, fabrication and installation of all types of water conditioning equipment

AS WELL AS

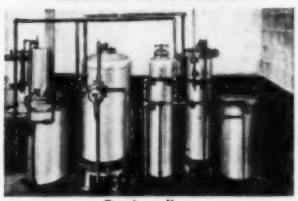
Development and application of all types of water conditioning methods and processes

Write Today for Graver Catalogues

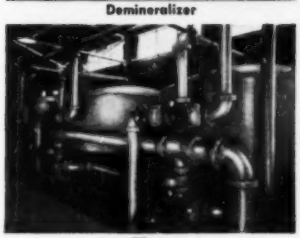
There is no obligation for analysis of raw water samples and our recommendations concerning specific problems.



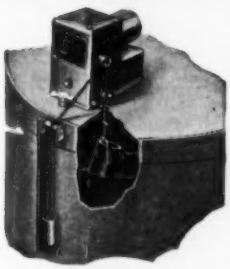
Reactivator Cold Process Unit



Demineralizer



Filters



Chemical Feeder

GRAVER WATER CONDITIONING CO.

216 W. 14th ST., NEW YORK 11, N. Y.

CHICAGO • PHILADELPHIA • CLEVELAND

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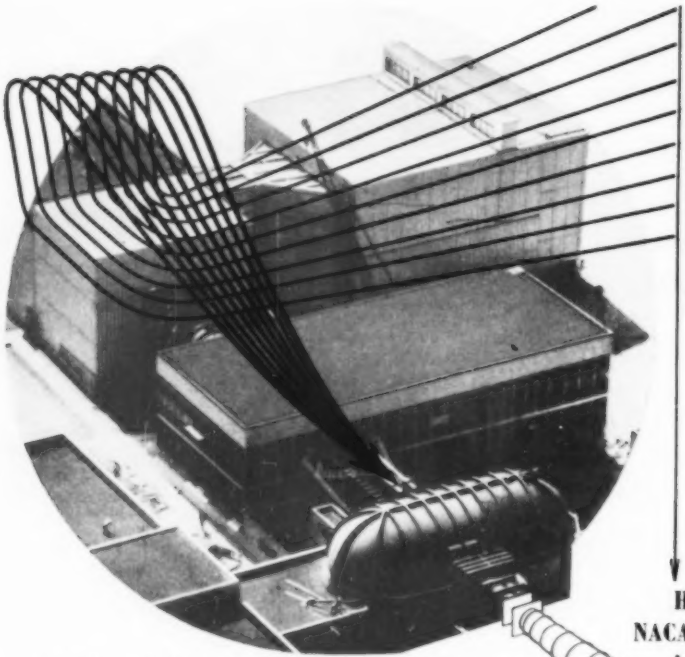
A DIVISION OF GRAVER TANK & MFG. CO., INC. EAST CHICAGO, IND.



The National Advisory Committee for Aeronautics' giant supersonic wind tunnel. Photo, taken before the enclosure was completed, shows the huge conical diffuser through which air is discharged.

Drying 2,200,000 cubic feet of air per minute

How Activated Alumina helps NACA attain supersonic air speeds in a simulated stratosphere

Supersonic speeds nearly twice the speed of sound—and stratospheric conditions normally met at 35,000 feet *up*—are now brought down to earth in the world's largest supersonic wind tunnel at Cleveland, Ohio.

To simulate supersonic speeds at 35,000 feet of altitude, as much as 2,200,000 cubic feet of air, *per minute*, must be blown through the titanic "horn" at the newest NACA aeronautical research laboratory. But this air also must be dried to a *minus* 10°F. dew point before it is passed through the test section of the tunnel—a problem heretofore never considered for such a huge quantity of air.

To obtain this dryness, the air is passed through gigantic beds of ALCOA Activated Alumina where moisture can be removed at the rate of *240 gallons of water per minute!*

Activated Alumina is suitable as the drying agent, because it can be relied upon to maintain its form and properties even after an almost unlimited number of regeneration cycles . . . because it is chemically inert, non-toxic and does not swell, soften or disintegrate even when immersed in water. Then too, ALCOA Activated Alumina is available in the enormous quantities required.

Besides aiding research, ALCOA Activated Alumina also helps manufacturers make better products through reliable and efficient dehydration of liquids, vapors and gases. Its desiccating properties are used in the chemical, food, pharmaceutical and petroleum industries, in air conditioning and for the maintenance of oils.

If you have a drying problem, it will pay you to investigate ALCOA Activated Alumina. Write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 1963M Gulf Building, Pittsburgh 19, Pa.

ALCOA CHEMICALS

ALUMINAS AND FLUORIDES

ACTIVATED ALUMINAS • CALCINED ALUMINAS • LOW SODA ALUMINAS • TABULAR ALUMINAS • HYDRATED ALUMINAS
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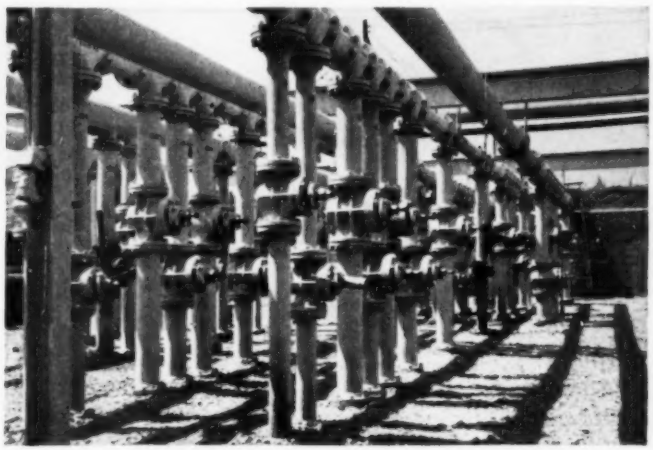
Made from Alloy Steel—from the furnaces of Republic, world's leading alloy steel producer.

Maintenance Headaches?

Here's a ready cure for maintenance headaches due to stud failures in vital refining equipment . . . and it takes effect the moment you install Republic Upson Alloy Studs wherever severe service conditions are encountered. Providing stubborn resistance to corrosion, high temperatures and heavy pressures, these tough, heavy-duty studs deliver dependable, trouble-free performance under all operating conditions.

Better yet, start out right by specifying Republic Upson Alloy Studs in new equipment before maintenance headaches begin.

REPUBLIC STEEL CORPORATION
BOLT & NUT DIVISION • CLEVELAND 13, OHIO
Export Department: Chrysler Building, New York 17, New York



REPUBLIC *Upson Quality* **ALLOY STEEL STUDS**

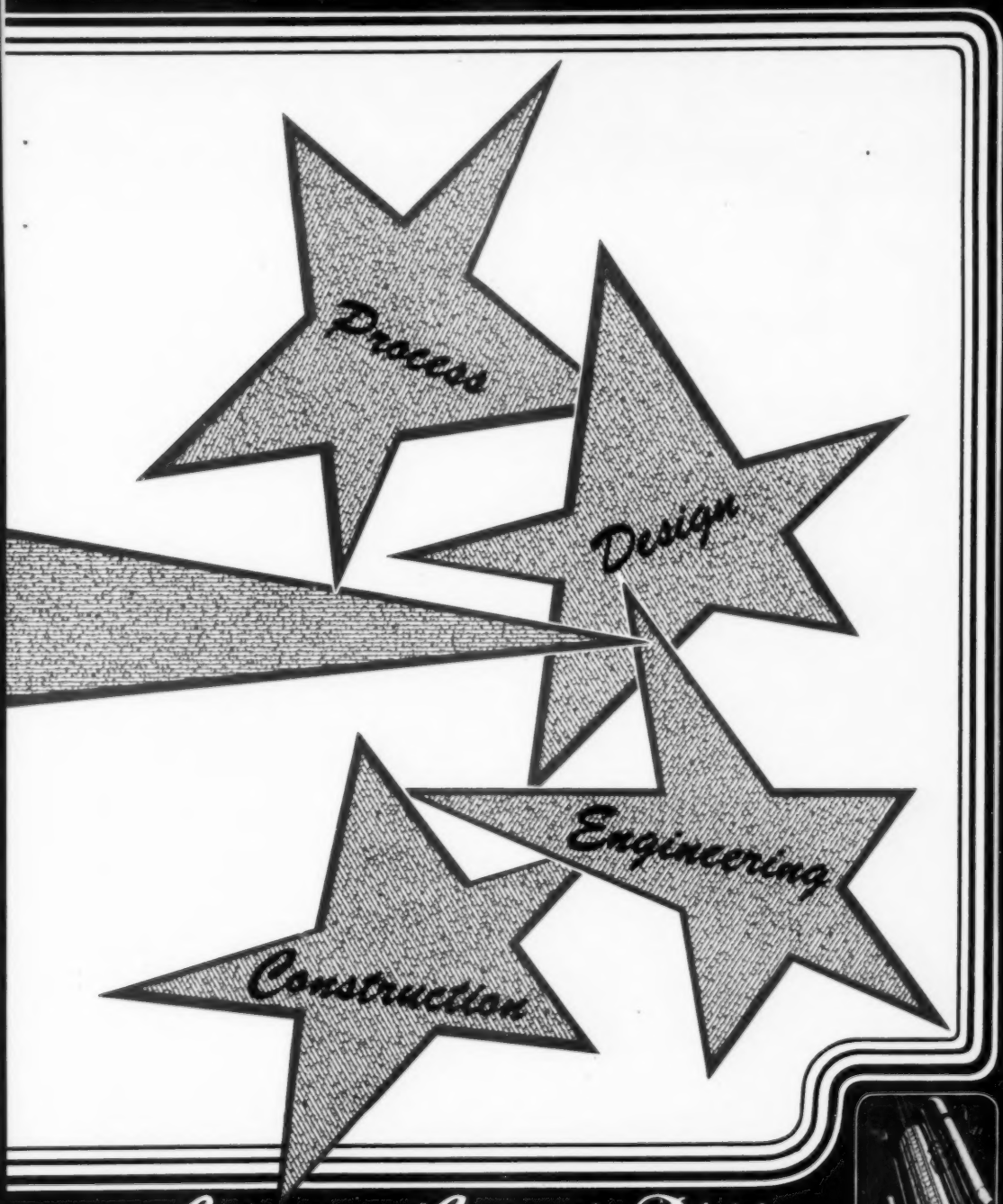
Other Republic Products Include Machine, Tank and Carriage Bolts—Lag Screws, Cap Screws and Rivets

Maximum recovery and minimum operating expense are never accidental qualities in a petroleum processing plant.

The economical accomplishment of successful processing calls for experience as well as technical knowledge and conscientious procedure. There are no substitutes.

We are qualified to design and erect many types of petroleum processing plants. We welcome undivided responsibility for process selection, design, engineering, and construction. Our credentials are the plants we have built.

We serve you best when allowed to counsel with you from the time your need for a plant becomes obvious.



Engineering and Construction Division

JONES & LAUGHLIN SUPPLY COMPANY

TULSA, OKLAHOMA

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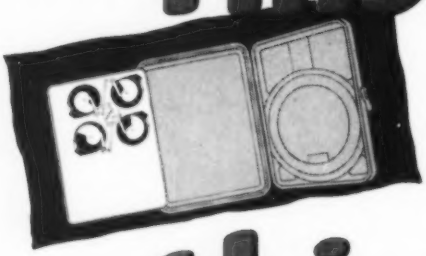

...or this

More than 100,000 different instrument combinations are now possible from four basic circuits and eight basic component parts. That's how Bailey has simplified electronic controls for processing industries.

No matter what your process may be, you can use Bailey controls for flow, temperature, pressure, level, speed, gas analysis, pH, conductivity, etc. Four circuits and eight basic parts are all you need. You don't have to carry a large stock of replacement parts. Bailey parts are interchangeable. The units you use for one control can quickly be adapted to another.

To learn how Bailey controls can save you money and speed up control installations, write for a copy of Bailey Bulletin No. 17.

or 100,000 other instrument combinations
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P-18-O

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BAILEY METER CO. LIMITED, MONTREAL
Controls for the Oil Industry
TEMPERATURE • FLOW • PRESSURE
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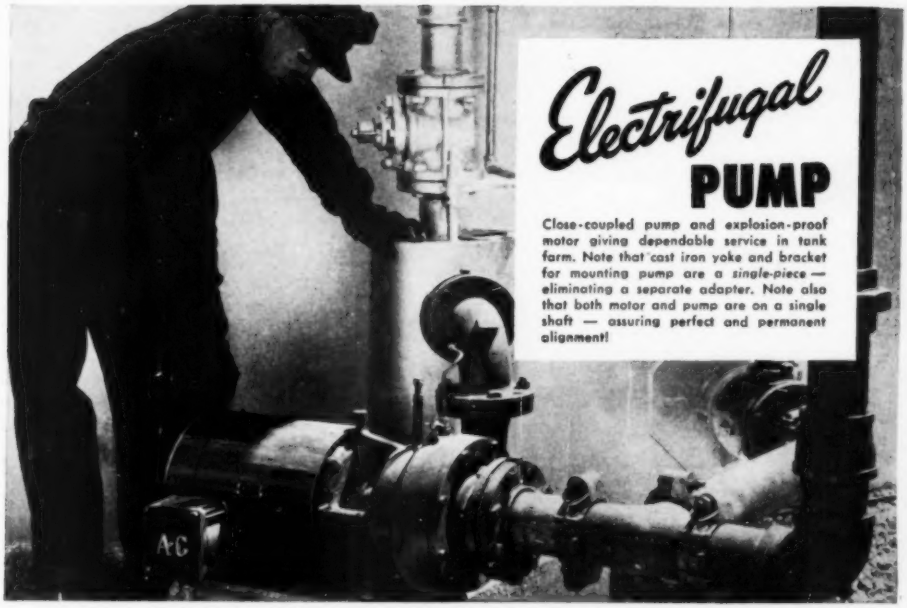
4 + 8 Works Here . . .
Port Arthur Refinery of Gulf Oil Corporation where Bailey Instruments are helping to refine petroleum.

How Unit Construction Cuts Petroleum Pumping Costs


Electrifugal
PUMP
Close-coupled pump and explosion-proof motor giving dependable service in tank farm. Note that cast iron yoke and bracket for mounting pump are a single-piece — eliminating a separate adapter. Note also that both motor and pump are on a single shaft — assuring perfect and permanent alignment!
A-C

SAVES YOU MONEY THESE 3 WAYS:

- **In Installation** — Installation is easier, quicker — pump comes ready to run. No alignment problems. No extra parts. Easy to handle. Requires small space.
- **In Operation** — Pump and motor designed together to give high efficiency. Every unit tested and guaranteed.
- **In Maintenance** — Cannot get out of alignment. Has fewer parts and fewer machined fits. Bronze wearing ring protects casing from wear and is easily replaced when required.

The *Electrifugal* pump, ranging from 10 to 1600 gpm with heads to 525 feet, is just one of many types of pumps built by Allis-Chalmers for industrial service. You can depend on the recommendations of the A-C pump application engineer to give you dependable service at lowest cost. For information, see your Allis-Chalmers Authorized Dealer or Sales Office or write for Bulletin 52B6059E. A-2774

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Electrifugal and *Texrope* are Allis-Chalmers trademarks.

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Power, Electrical, Processing Equipment for Petroleum Industry

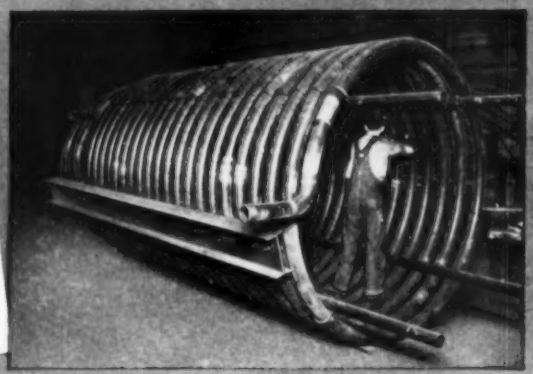
MIDWEST PIPE COILS

ANY SIZE . . .
ANY SHAPE . . .
ANY PIPING MATERIAL . . .
FOR ANY PURPOSE

Whatever your pipe coil requirements may be . . . whether carbon steel or alloy . . . Midwest has undoubtedly fabricated similar units. This experience . . . aided by the special coiling equipment developed by Midwest . . . is the reason why many of the most exacting coil users prefer coils by Midwest.

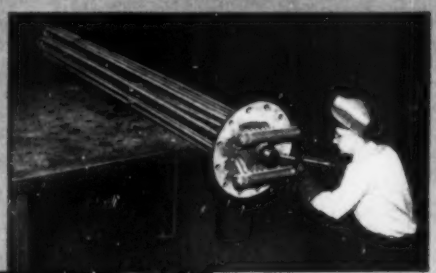
Midwest coils are accurate to dimension, thoroughly pressure tested, stress relieved when necessary, carefully cleaned . . . ready for long, satisfactory service.

Midwest engineers will gladly assist you in the solution of your pipe coil problems. Get in touch with the nearest office.

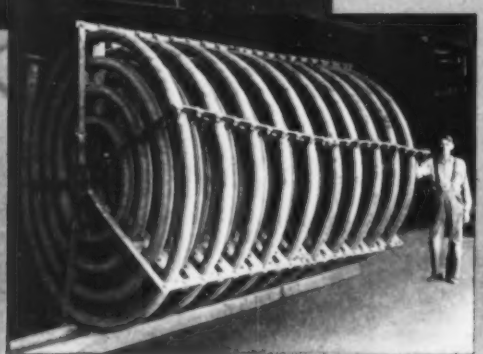


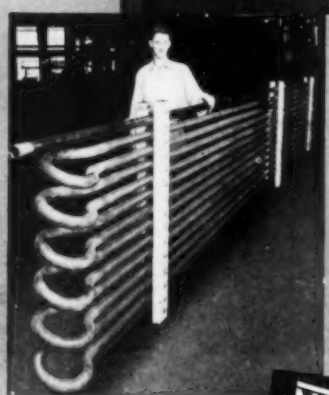
Cylindrical coil of polymerization heater coil approximately 8 ft in diameter and containing 850 ft of 4" standard Grade "A" seamless steel pipe.

A nest of box coils containing 850 ft of 2" extra strong seamless pipe, to be used as storage tank heater.



Catalytic reactor coil consisting of 20 flat spirals of 4½" OD x ¼" wall 4-6% chrome, ½% moly seamless pipe. Full-furnace annealing distorted temporary shipping straps.





Nested hairpin coil used as unit heater in 14" diam tank; made from 300 ft of ⅜" OD x #14 BWG seamless boiler tubing.

Condenser coil fabricated from 2" OD x ⅜" wall seamless steel pipe. Coil was tested to 7500 psi and is 26 ft long.

MIDWEST PIPING & SUPPLY COMPANY, Inc.
Main Office: 1450 South Second St., St. Louis 4, Mo.

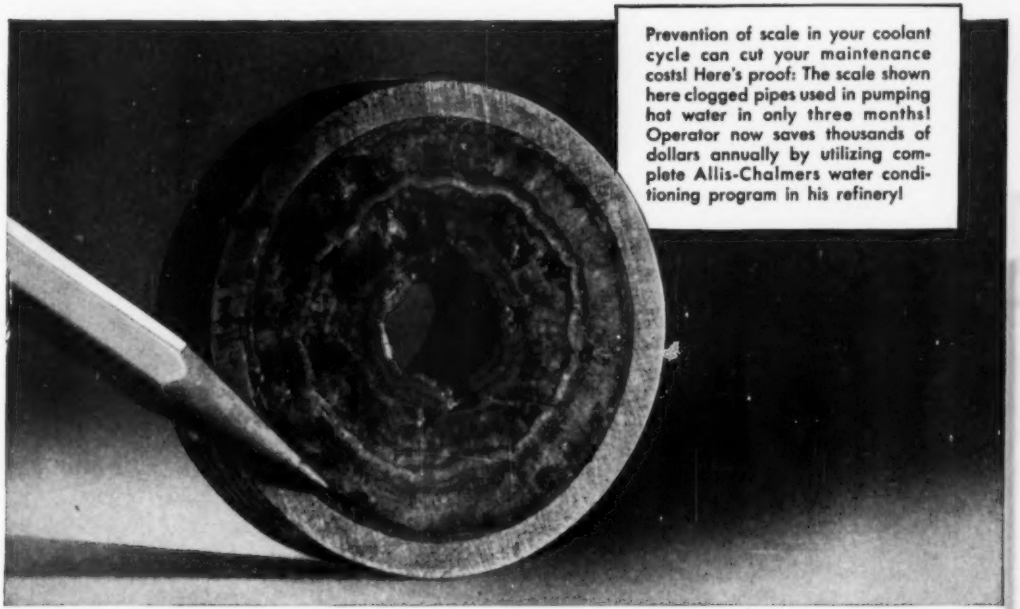
Plants: St. Louis, Passaic, Los Angeles and South Boston • Sales Offices: New York 7—30 Church St. • Chicago 3—79 W. Monroe St. • Los Angeles 33—520 Anderson St. Houston 2—229 Shell Bldg. • Tulsa 3—533 Mayo Bldg. • South Boston 27—426 First St.

MIDWEST PIPING SERVICE IS NATION-WIDE

4 PLANTS ARE BETTER THAN 1

PIPING FABRICATORS AND MANUFACTURERS OF WELDING FITTINGS

Prevent Profit-Stealing Scale in Your Refinery



Prevention of scale in your coolant cycle can cut your maintenance costs! Here's proof: The scale shown here clogged pipes used in pumping hot water in only three months! Operator now saves thousands of dollars annually by utilizing complete Allis-Chalmers water conditioning program in his refinery!

A-C SUPPLIES COMPLETE WATER CONDITIONING SERVICE—EQUIPMENT—CHEMICALS

SCALING AND HOT RUN-DOWN STREAMS can waste thousands of dollars annually in your refinery! Your master mechanic or head stillman knows your needless expenditures for excess condenser maintenance, product loss and down-time of process units.

Allis-Chalmers does not offer a "cure-all" for the scaling problems in any coolant cycle. We recognize that every problem is different—depending upon raw water analysis, per cent of make-up, etc. After a careful study of all the factors involved, A-C specialists can recommend an efficient process or equipment for your particular needs:

SERVICE: Complete analysis of water supplies; reports on water-steam cycle; study of equipment; advice on selection of chemicals; periodic reports and service calls.

CHEMICALS: Scale inhibitors for all heat exchanger cycles. Special chemicals to prevent boiler scale, control corrosion, reduce silica, and correctly condition sludge.

EQUIPMENT: Hot and cold process softeners, sodium and hydrogen zeolite softeners, degasifiers, deionizers, chemical proportioners, oil removal and water filters.

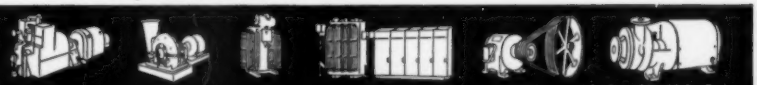
For prompt assistance with *any* water conditioning problem, call your nearby A-C Sales Office, or write direct. A 2791

ALLIS-CHALMERS, 1062A SO. 70 ST.
MILWAUKEE, WIS.

ALLIS-CHALMERS

Texrope is an Allis-Chalmers trademark.

Power, Electrical, Processing Equipment for Petroleum Industry



ARE YOU A REFINER WITH A
"Flair"
FOR EXTRA PROFITS?
POROCEL converts flare gases to elemental sulfur
With more and more refineries running sour crudes, the problem of sulfide disposal becomes increasingly important. Ordinarily flared, these gases are now being utilized by converting them into premium grades of sulfur—hence into extra profits—through the use of Porocel.
Porocel catalyzes the reaction: $2H_2S + SO_2 \longrightarrow 3S + 2H_2O$. The element of catalyst cost is extremely favorable, since Porocel is low in first cost and displays a long life.
This is another example of Porocel serving the petroleum industry—another reason why it pays to know the *whole* Porocel "family" of activated bauxites. Included are:
Adsorbents—with high selectivity for removal of colors, odors, tastes, acids, fluorides, etc., from process liquids or gases.
Carriers—embodying ruggedness and adsorptive properties for use as catalyst supports.
Catalysts—high-surface-area materials for desulfurization* and reforming* systems, and for other catalytic duties.
Desiccants**—for drying petroleum gases and liquids, air, CO_2, etc.
May we introduce *you* to the Porocel that's "engineered" to your specific needs? Attapulgus Clay Company (Exclusive Sales Agent), Dept. W, 210 West Washington Square, Philadelphia 5, Pa.
* CYCLOCEL ®
** DRIOCEL ®
POROCEL CORPORATION
ACTIVATED BAUXITES • SUPPORTED CATALYSTS • CATALYST CARRIERS • ADSORBENTS AND DESICCANTS

Shell Oil Refinery Gets Safe, Efficient Power Distribution

DESIGNED FOR QUICK INSPECTION—LOW MAINTENANCE

ELECTRIC POWER SUPPLY is protected and distributed at the Shell Oil company refinery, Deer Park, Texas, by this 5000 kva double-ended Allis-Chalmers Unit Substation consisting of two 2500 kva transformers and a 12 feeder section of switchgear.

Shell Oil company gets these results: ▸ pleasing appearance; ▸ maximum safety for workmen; ▸ reduced maintenance and inspection; ▸ compactness; ▸ flexibility for expansion.

Every part of this Allis-Chalmers Unit Substation is built with attention to details of construction and arrangement that result in maximum protection . . . quicker inspection . . . reduced maintenance.

Devices like potential and control transformers that are *drawout mounted* for greater accessibility — finger-type disconnects located on the *removable breaker element* for ease of inspection — are good points to compare when buying unit substations for your electric power distribution system.

You gain initially with less paper work, quicker installation for added economy. Allis-Chalmers assumes undivided responsibility for performance of the *complete* substation! Call your nearby A-C representative. Or, write direct.

A-2873

ALLIS-CHALMERS, 1062A SO. 70 ST.
MILWAUKEE, WIS.

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A-C ALLIS-CHALMERS

ALLIS-CHALMERS

Power, Electrical, Processing Equipment for Petroleum Industry

In Refineries, FLEXIBILITY COUNTS

GET POWER WITH

In oil refineries, where modernization programs frequently require shifting of equipment from place to place within the plant, drives with flexibility of application are a "must". This is one more reason why General Electric's STANDARD line of mechanical-drive turbines is winning such popularity in the petroleum industry. They can be easily transferred from one job to another, their speed and range changed easily, and their horsepower rating adjusted economically.

DP TURBINES PROVIDE FLEXIBILITY THREE WAYS

1. EASY TO RE-LOCATE

Shaft height is the same on all G-E standard single-stage turbines. This means that moving turbines from one job to another doesn't require a "custom line-up job." Not only shaft height, but size of coupling fit and keyways are standard on every unit.

DP turbines are quickly aligned, too. Unless casing temperatures are high, DP's can be lined up cold with the assurance that shaft lift will be within allowable limits when the turbines are heated. Such easy alignment is possible only on a center-line supported unit.

2. EASY TO ADJUST SPEED

By adjusting a simple handwheel, the speed setting can be varied within a 30% range. Once adjusted, the DP's hydraulic governor holds speed accurately.

If a change in application makes a new speed range necessary, the range can be set anywhere from 800 to 5000 rpm by simply substituting a new emergency governor and a new set of low-cost gears on the governor drive. These gears are standard, available on immediate delivery from the factory.

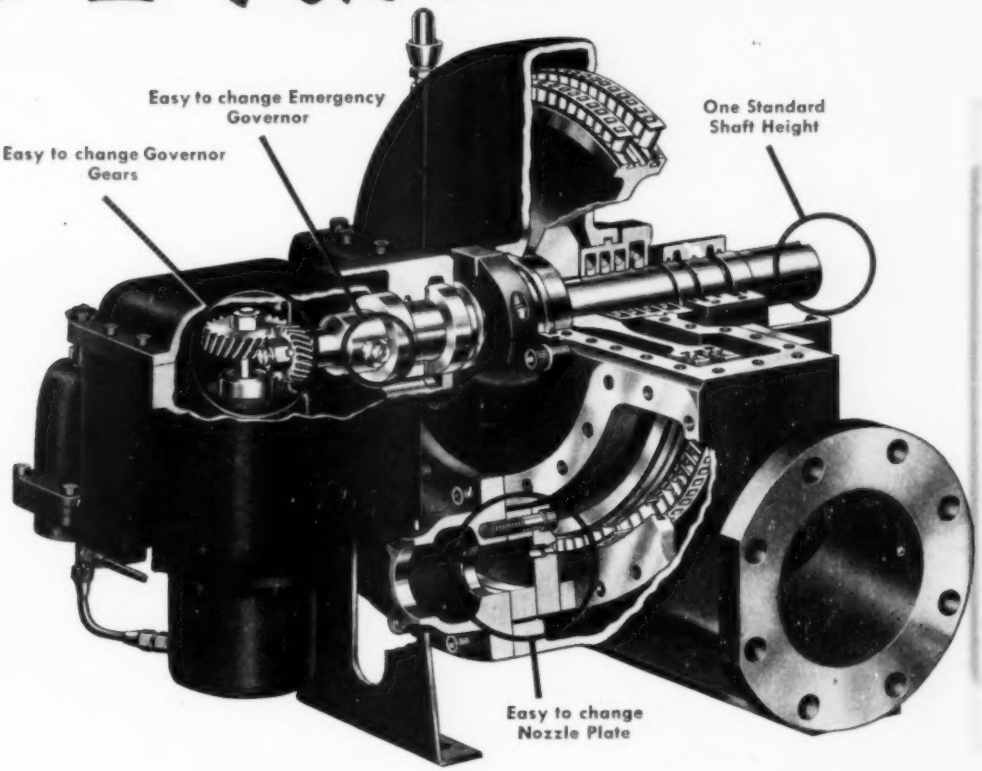
3. EASY TO CHANGE RATING

When steam conditions or load demands change, a DP turbine can be adapted at a reasonable cost for the new requirements if they are within the steam flow capacity of the casing. Example: If it is desired to increase the horsepower rating, the only changes which are usually necessary are new nozzle plate and valve parts. The cost of such parts is far less than the cost of a new turbine—which would be required with a less flexible unit.

REMEMBER...

"DP means Dependable Power"

FLEXIBILITY G-E TURBINES



The General Electric standard DP Turbine incorporates many outstanding features previously found only on "special" turbines. They give you a drive which is dependable and flexible—ideal for application in the oil industry.

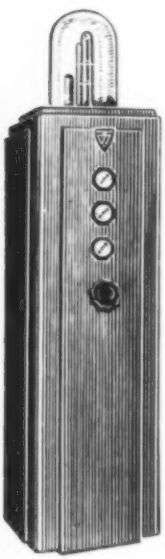
For the full story on how these features can mean operating benefits for you, call your G-E representative. Or write today for GEA-4955, a 20-page, descriptive bulletin. Apparatus Dept., General Electric Co., Schenectady 5, N. Y.

GENERAL ELECTRIC

APARTMENT FOR SLIME

With condenser tubes handling unchlorinated water, slime-forming bacteria never have to worry about a housing shortage. Instead, these bacteria move in, form their colonies, and the condenser tubes become apartments for slime. When this happens, the terminal log mean temperature difference rises, excess steam costs go up, and outage increases along with the labor bill for costly plug cleaning.

Chlorination, engineered by W&T and backed by 35 years' experience, has proven itself the effective answer to slime in condenser and heat exchanging equipment. It is effective because the Wallace & Tiernan De-Sliming Process attacks the cause of slime, bacteria, and "evicts" these unwanted "tenants" from their home in your equipment.



CD-32

Regardless of whether yours is an open or closed cooling system or whether you use shell and tube, trombone, or open box condensers, Wallace & Tiernan engineering plus time-tested W&T Chlorinators can put all the money-saving advantages of slime control by chlorination to work on your condensers or heat exchange equipment.

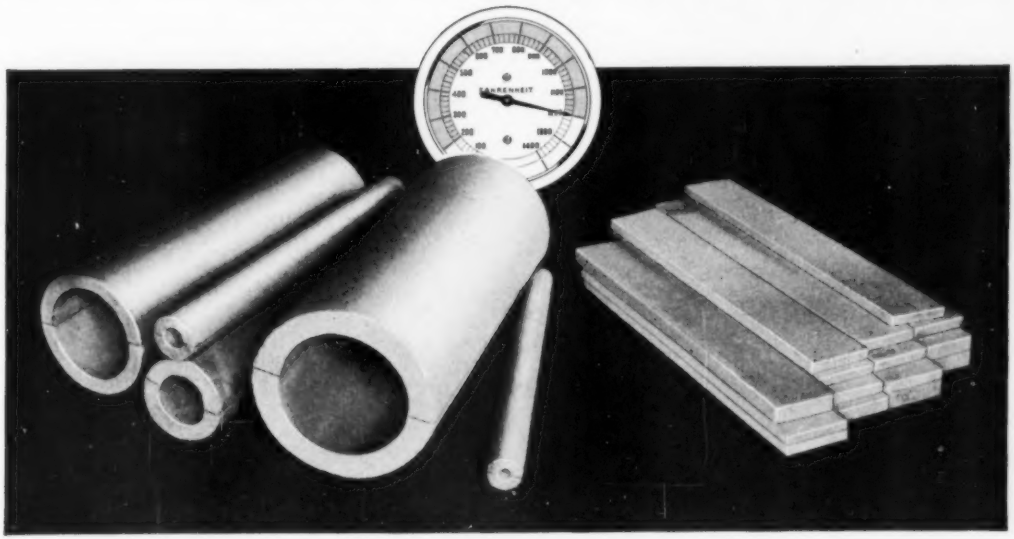
Write today for complete information.

WALLACE & TIERNAN
PRODUCTS, INC.

CHLORINE AND CHEMICAL CONTROL EQUIPMENT

Belleville 9, New Jersey • Represented in Principal Cities

ONE MATERIAL INSULATES A 200°F.-1200°F. TEMPERATURE RANGE



KAYLO HEAT INSULATING BLOCK can be easily sawed, cut and scored with standard tools. Cement, cloth or other outer finishes can be applied with minimum effort. Finished jobs have a neat, clean appearance.

KAYLO PIPE INSULATION is produced in Simplified Dimensional Standards of thicknesses and diameters for snug layering, when necessary. Available in thicknesses from 1 to 3 inches in 36-in. sections, for pipe sizes from ½ inch to 12 inches.

Every engineer concerned with insulation problems should know about Kaylo Heat Insulating Block and Pipe Insulation. No other insulation provides such a combination of advantages.

Available in block or pipe covering form, this material is remarkably efficient throughout a wide 200°-1200° temperature range. It is strong and resistant to effects of moisture for long service. It is lightweight, easy to handle and apply.

Many types of industries have found this material ideal for their insulating needs. Get the facts now about Kaylo Heat Insulating Block and Kaylo Pipe Insulation.

KAYLO®

HEAT INSULATING BLOCK and PIPE COVERING

OWENS-ILLINOIS GLASS COMPANY
Kaylo Division Toledo 1, Ohio

SALES OFFICES AT:

Atlanta	Chicago	Minneapolis	St. Louis
Boston	Cincinnati	New York	Toledo
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MAIL COUPON FOR KAYLO INSULATION SAMPLES AND LITERATURE

Owens-Illinois Glass Company
— Kaylo Division Dept. F-430, Toledo 1, Ohio

Gentlemen: Please send me Kaylo heat insulation samples and descriptive literature.

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CITY..... STATE.....

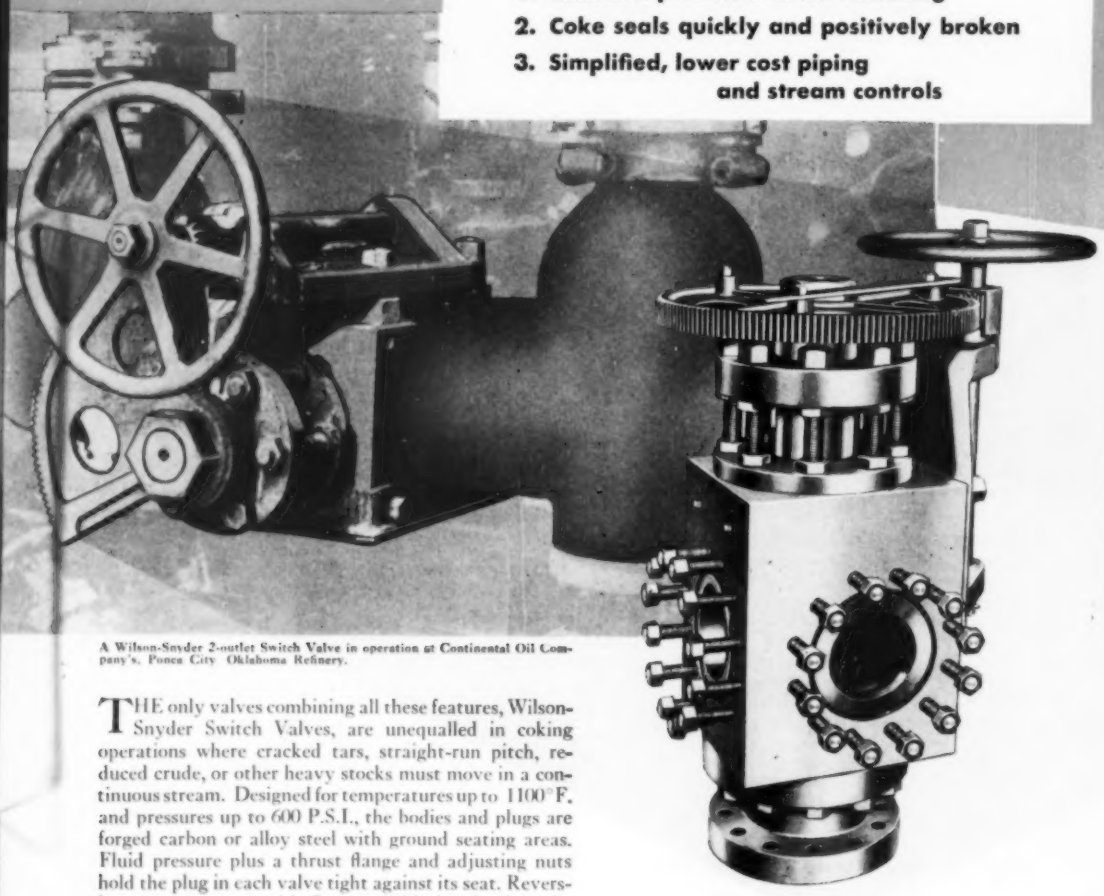
PLANNING ON RUNNING TO COKE?

Then you'll want

WILSON-SNYDER SWITCH VALVES

to insure:

1. Uninterrupted flow when switching
2. Coke seals quickly and positively broken
3. Simplified, lower cost piping and stream controls



A Wilson-Snyder 2-outlet Switch Valve in operation at Continental Oil Company's, Ponca City Oklahoma Refinery.

THE only valves combining all these features, Wilson-Snyder Switch Valves, are unequalled in coking operations where cracked tars, straight-run pitch, reduced crude, or other heavy stocks must move in a continuous stream. Designed for temperatures up to 1100°F. and pressures up to 600 P.S.I., the bodies and plugs are forged carbon or alloy steel with ground seating areas. Fluid pressure plus a thrust flange and adjusting nuts hold the plug in each valve tight against its seat. Reversing nut pressure on this flange quickly breaks the coke seal.

Wilson-Snyder Switch Valves are available in sizes from 2" to 10" with single inlet and two, three, or four outlets, or the reverse. Connections to suit your requirements can be furnished in any case.

Your local "Oilwell" representative will gladly give you complete information on Wilson-Snyder Switch Valves and pumps for all refinery applications.

Close-up view of a Wilson-Snyder Switch Valve ready for installation.

OIL WELL SUPPLY COMPANY

Branches Serving All Oil Fields

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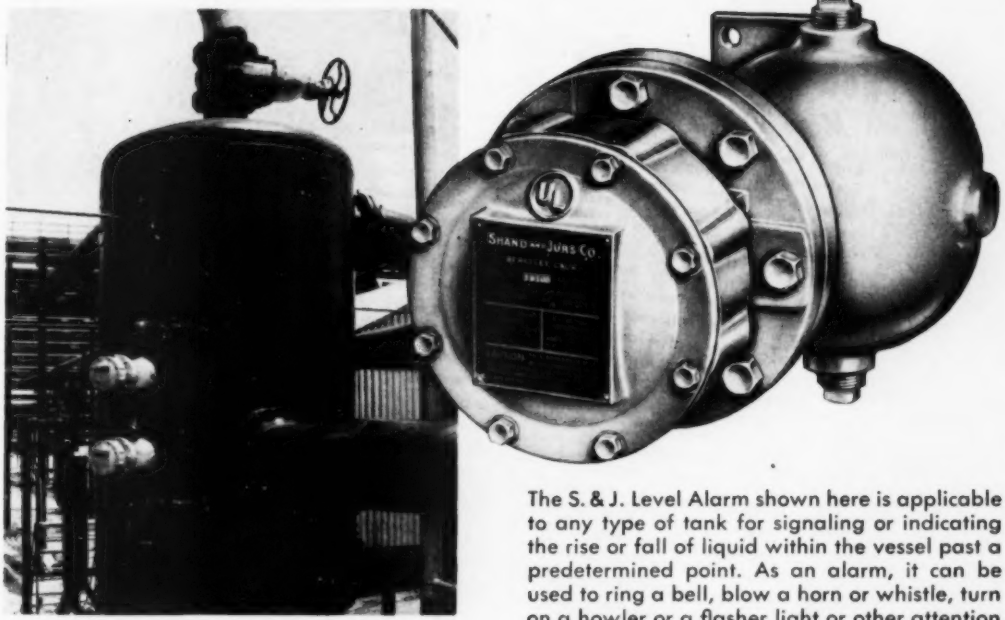
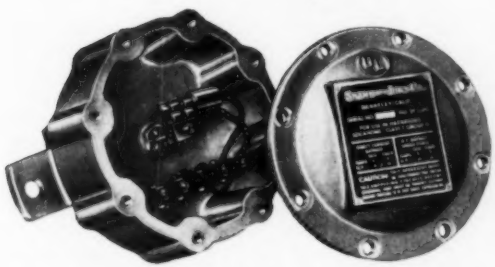
USS "OILWELL"

UNITED STATES STEEL

GREATER SAFETY WITH S & J LEVEL ALARM ON GUARD



S. & J. Automatic Level Alarm installed on a scrubber at the Gladewater, Texas, plant of the Warren Petroleum Corporation.



The S. & J. Level Alarm shown above is listed by Underwriters Laboratories for use in Class 1, Group D, hazardous locations. The body of this explosion-proof switch box is of cast aluminum with threaded hub to accommodate stainless steel operating shaft. Another threaded outlet is provided in the bottom for conduit connection. One mercury switch is provided as standard equipment, a second switch may be added at extra cost, as box will accommodate two switches with terminal blocks.

The S. & J. Level Alarm shown here is applicable to any type of tank for signaling or indicating the rise or fall of liquid within the vessel past a predetermined point. As an alarm, it can be used to ring a bell, blow a horn or whistle, turn on a howler or a flasher light or other attention commanding device, thus enabling operating personnel to correct an unsafe condition before it becomes critical. This alarm is also widely used to close electric circuits, ground out magnetos, and close relays.

This alarm is available in two types: The Fully Automatic (Figure ST-5230A) will continually repeat its alarms until the condition causing the continual tripping is corrected. The Manual Reset Type (Figure ST-5230M) requires manual resetting after having tripped, thus assuring the opportunity of determining each cause of tripping. The bodies of these level alarms are of cast steel, designed for 300 pound service. All trim is of stainless steel. Both types are equipped with Mercury Switches enclosed in the explosion-proof switch boxes illustrated at the left.

SHAND & JURS CO.
BERKELEY, CALIFORNIA

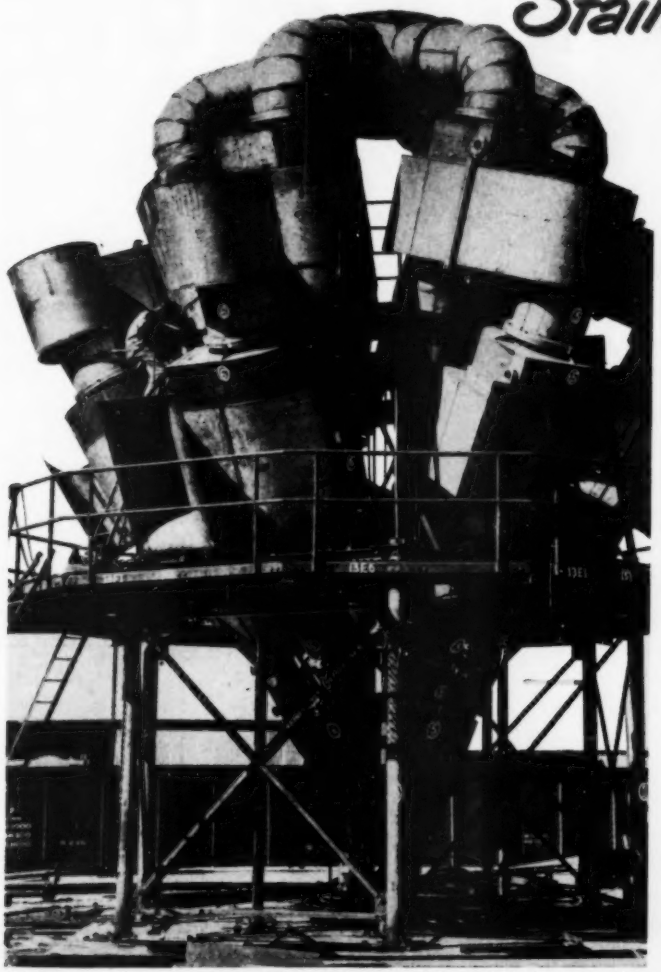
NEW YORK CHICAGO HOUSTON LOS ANGELES SEATTLE

SHAND & JURS

H_3BO_3
HCl
$C_2H_4O_2$
C_6H_6
NH_4OH
C_6H_6
H_2S
$C_4H_3O.CH_2OH$
NH_3
HNO_3
NH_4OH
SO_2
C_6H_7N
$H_4P_2O_6$
C_2H_4
H_2SO_4
$C_{14}H_{10}$
$(NH_4)_2S$
C_2H_4
S
C_3H_6O
$C_{14}H_{10}$
NH_4F
CH_3COOH
NH_4Cl
Non-Corrosive Cooling Towers
More Vital Than You May Think
Even if the water to be cooled contains no traces of any corrosive chemical, though it often does, the air near the tower may bear corrosive fumes, emanating from your plant or from another plant adjacent to yours. These fumes drawn through the tower and mixing with the falling water can have a destructive effect on fans and interior hardware of water cooling towers. That's why fan blades for large and medium size C. H. Wheeler towers are made of non-corrosive plastic; also why bolts, nuts and nails may be supplied in either brass, copper, or standard galvanized steel. Tests and long successful experience of users have proved these plastic fans are immune to the attack of dilute solutions or fumes of the chemical compounds indicated by these formulae, and many others. Of course, the interiors of all C. H. W. towers are made of redwood, obviously non-corrosive, and the casings are of redwood, asbestos cement board, masonry, brick or properly painted steel. . . . Plastic fans and C. H. Wheeler water cooling towers have numerous other superiorities, fully described in descriptive literature. Write for it.
C. H. WHEELER MANUFACTURING CO.
1818 Sedgley Avenue, Philadelphia 32, Pa.
REPRESENTATIVES IN MOST PRINCIPAL CITIES
SINCE 1903
C.H. Wheeler
STEAM CONDENSERS • WATER COOLING TOWERS
EJECTORS • STEAM JET VACUUM REFRIGERATION
OF PHILADELPHIA

THE MORE SEVERE THE SERVICE

—the greater the need for Stainless Steel



U·S·S Stainless Steel was used extensively in the fabrication of this Buell Van Tongeren catalyst collector by the Wyatt Metal & Boiler Works, Houston, Texas.

There are three important reasons why the petroleum refining industry turns to U·S·S Stainless Steel to meet its most severe corrosion problems:

- **No other commercial metal can equal Stainless Steel in its high resistance to so many different types of corrosives.**
- **Stainless Steel is unsurpassed for retaining its strength under extremely high temperatures.**
- **U·S·S Stainless Steel is available in a wide range of analyses, and in many different forms — sheets, strip, plates, wire, bars, pipe and tubing. As a result, it will meet almost any fabricating requirement and service condition.**

The many outstanding advances and the immense expansion program undertaken by the refining industry in recent years have placed unusual and increasingly stringent demands on processing equipment. But Stainless Steel has kept pace, meeting these new conditions with corrosion-resisting and heat-resisting analyses that yield outstanding performance under today's requirements.

In all types of jobs . . . in all types of equipment . . . Stainless Steel is holding equipment deterioration to a minimum and keeping down costly product losses.

U·S·S Stainless Steel is a perfected, service-tested material, uniform in finish and in fabricating qualities. Our engineers, specialists in Stainless and its application, will be glad to work with you in selecting the grade of Stainless that will give you the ultimate in performance.

AMERICAN STEEL & WIRE COMPANY, GENERAL OFFICES: CLEVELAND, OHIO · CARNEGIE-ILLINOIS STEEL CORPORATION, PITTSBURGH & CHICAGO
COLUMBIA STEEL COMPANY, SAN FRANCISCO · NATIONAL TUBE COMPANY, PITTSBURGH · TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM
UNITED STATES STEEL SUPPLY COMPANY, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

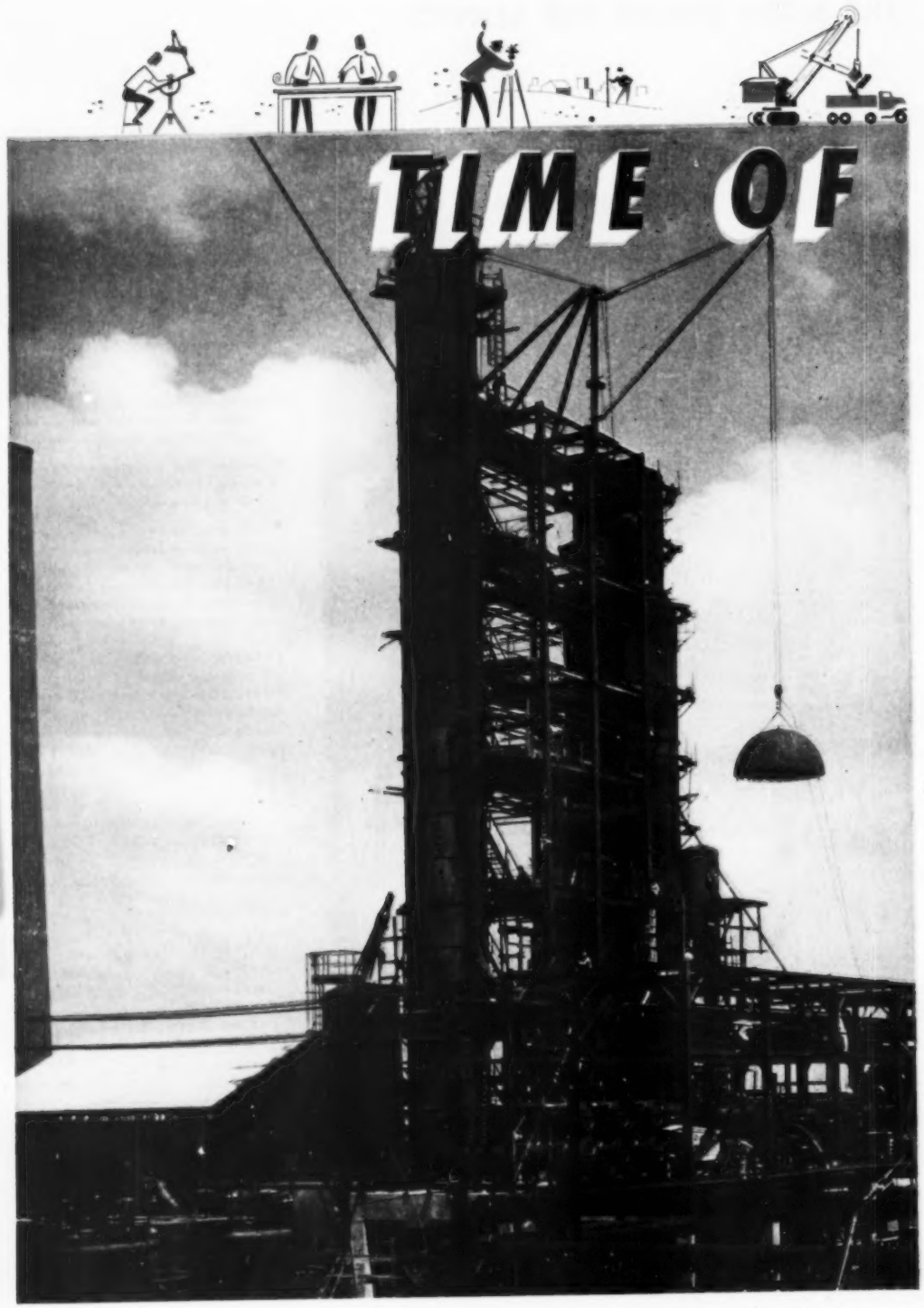
USS

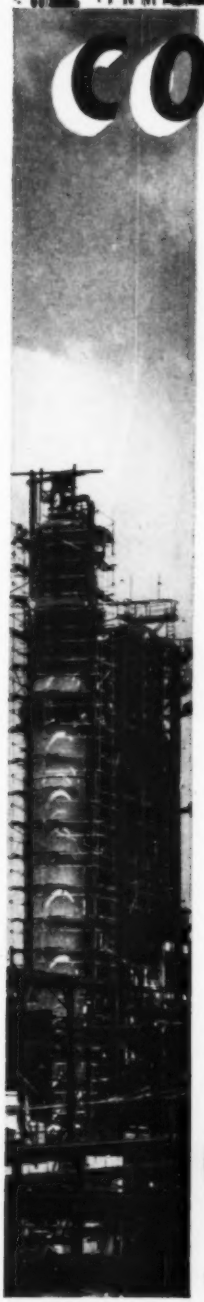
U·S·S STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

9-2009

UNITED STATES STEEL


TIME OF



COMPLETION ...is always important

Badger has always felt it of utmost importance that every client know just what he can reasonably expect in the way of completion dates.

In the early post-war years when refiners and chemical manufacturers were scrambling to install sorely needed new facilities, this company took pains to explain to clients just how current work commitments would affect our ability to undertake designs on new work.

Because we did not undertake work on projects unless we were able to devote to them adequate attention, the start of a job was sometimes deferred. The actual time from start to *finish*, however, was always creditable, and there are outstanding examples demonstrating that the quickest start does not always mean the quickest completion.

Now that competition has returned to all business, and lost operating time for a new plant means more lost profits than ever before . . . Badger is right at home.

We have always conducted our operations in the belief that time of completion is a most important consideration.

E. B. BADGER & SONS CO. Est. 1841

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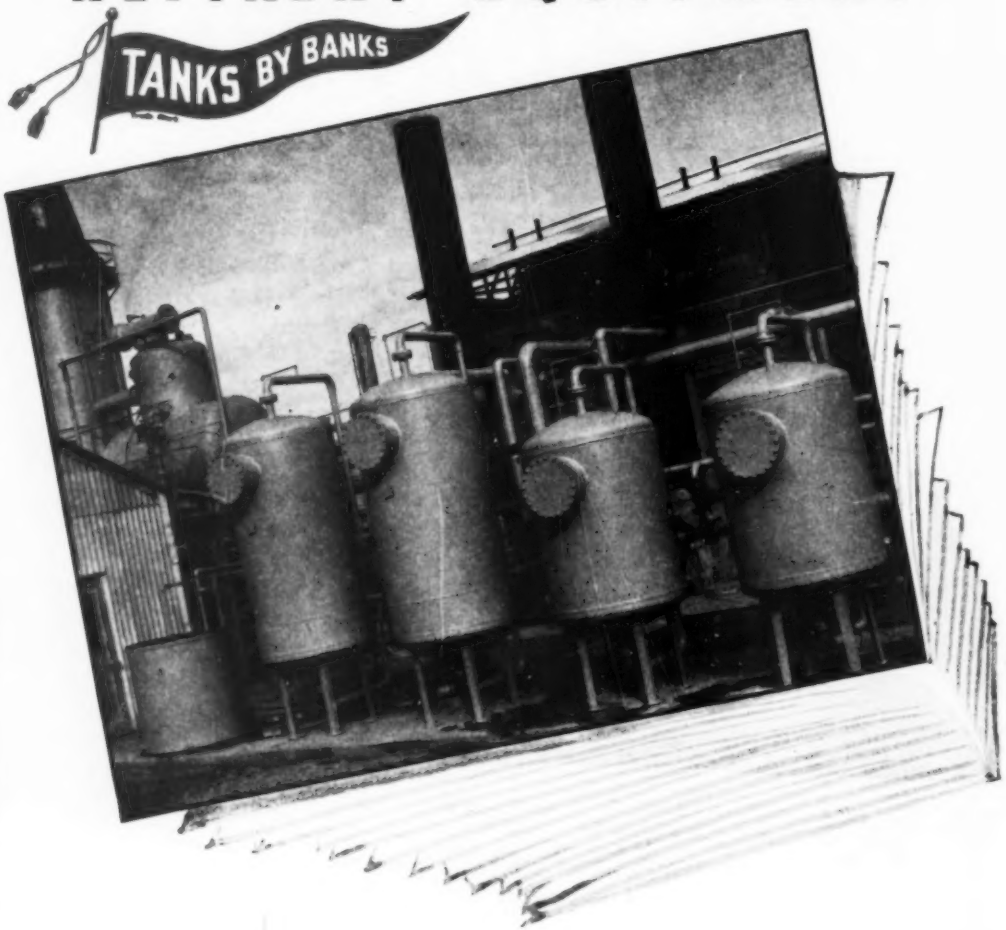
A SUBSIDIARY OF STONE & WEBSTER, INC.

PROCESS ENGINEERS and CONSTRUCTORS for the CHEMICAL, PETROLEUM and PETRO-CHEMICAL INDUSTRIES

TOPS IN . . .
REFINERY EQUIPMENT



TANKS BY BANKS means refinery equipment of top quality from drafting board to completed fabrication.

DALLAS TANK COMPANY, INC.

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DALLAS, TEXAS

Just off the press!

A new arc welding machine catalog—
Welders for AC, DC, gas engine operation
—capacities of 100 to 500 amperes.

Here, at last, is a helpful booklet that gives you complete data on all Airco arc welders — the machines with the stinger that penetrates. Divided into easy-to-read sections, you can quickly determine the welder suited to your production or maintenance job.

This booklet is handy, useful, bringing you a wealth of information covering design, distinctive features, specifications, power requirements, electrical characteristics, and outstanding operational qualities of each welder in the entire Airco line.

To give you some idea of the amount of material covered by this definitive booklet, here are a few of the many welders covered.

- "Bumblebee" and MCT — Transformer AC Arc Welding Machines
- "Hornet" 36A and "Wasp" — DC Arc Welding Machines
- "Yellow Jacket" Gas-Engine Driven Arc Welders
- Customer-Assembled Gas Engine Sets

See this booklet yourself . . . send for it today. Just fill in the coupon below for your free copy.

Send for this FREE catalog today!

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Please send me a copy of your NEW Arc Welding Machine Catalog No. 8.

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Southwestern Headquarters for Oxygen, Acetylene and Other Gases . . . Carbide . . . Gas Welding and Cutting Machines, Apparatus and Supplies . . . Arc Welders, Electrodes and Accessories

These are the tubes...

that stay on the job

CHASE

ANTIMONIAL ADMIRALTY

(a patented alloy)

Chase Antimonial Admiralty has been in use for 14 years, withstanding the test of time — *because* the percentage of antimony is *right*.

Admiralty containing less than .007% antimony (the minimum set forth in Chase Patent No. 2,061,921) cannot be counted on to prevent dezincification under all conditions. Over a wide range of applications, .015% is the minimum. Chase makes doubly sure you get this percentage—by using a nominal content of .035%, so that even with normal commercial variation your tubes contain at least .015% antimony.

That's why Chase patented Antimonial Admiralty tubes stay on the job, year after year. Get the facts!

Special stocks of ANTIMONIAL ADMIRALTY Condenser Tubes in Chase Warehouses: NEW YORK, BALTIMORE, NEW ORLEANS LOS ANGELES, SAN FRANCISCO

also carried by—
Vinson Supply Co., Tulsa
Standard Brass & Mfg. Co., Houston

Chase

WATERBURY 20 CONNECTICUT

SUBSIDIARY OF KENNECOTT COPPER CORPORATION

the Nation's Headquarters for
BRASS & COPPER

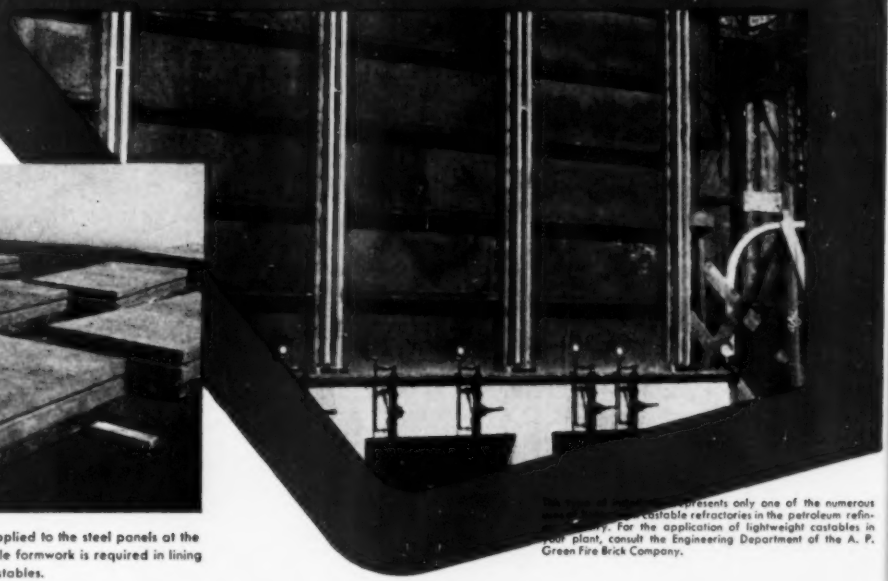
THIS IS THE CHASE NETWORK . . . *handiest way to buy brass*

ALBANY ATLANTA BALTIMORE BOSTON CHICAGO CINCINNATI CLEVELAND DALLAS DETROIT INDIANAPOLIS KANSAS CITY, MO LOS ANGELES MILWAUKEE MINNEAPOLIS NEWARK NEW ORLEANS NEW YORK PHILADELPHIA PITTSBURGH PROVIDENCE ROCHESTER ST. LOUIS SAN FRANCISCO SEATTLE WATERBURY (Sales Office Only)

Increase the Efficiency and Performance of OIL HEATERS and OIL STILLS with A. P. Green Lightweight *Castable Refractories*

Refractories are applied to the steel panels at the job-site. Only simple formwork is required in lining the panels with castables.

Erection is simplified by installation of pre-fabricated panels.



...presents only one of the numerous ...castable refractories in the petroleum refin... For the application of lightweight castables in ...our plant, consult the Engineering Department of the A. P. Green Fire Brick Company.

A. P. Green Castable Refractories applied to Panel Casing Construction in new or old oil heaters and stills, offers you these 6 advantages:

1. Use of lightweight castable refractory materials developed for high operating temperatures.
2. Securely anchored lining—gives long, trouble-free service.
3. Increases the performance and efficiency of the furnace. With fewer joints air infiltration is reduced to a minimum.
4. Simplified construction—reduces erection time.
5. Lowers maintenance costs. Any tube section may be repaired by removing a series of the panels without disturbing the balance of the furnace arrangement.
6. Lower foundation costs due to the use of lightweight materials.

The A. P. Green Fire Brick Company Engineering Department will assist you with further information on the application of these materials to new units or the conversion of existing furnaces. Call your local A. P. Green distributor—he's listed in the yellow pages of your telephone directory—or write . . .

A. P. Green REFRACTORY PRODUCTS

A. P. GREEN FIRE BRICK COMPANY

Mexico, Missouri, U. S. A.

A. P. Green Fire Brick Co., Ltd. in Canada

Distributors in the Principal Cities of the World

HERE IT IS!

. . . THE NEW MULTI-STAGE COOLING TOWER

. . . the result of 10 Years of Research and EXHAUSTIVE TESTS

. . . FOR THE WORLD'S LARGEST LUBE PLANT

Top view of the 48'-0" wide x 408'-0" long x 28'-6" high, 34-cell, Multi-Stage Cooling Tower designed and erected for the World's Largest Lube Plant.

51,000 Gallons of water per minute . . . 3,060,000 gallons of water per hour . . 73,440,000 gallons of water per 24-hour day . . . cooled to a guaranteed temperature with this 34-cell Multi-Stage Induced Draft Cooling Tower.

NEW IN *ENGINEERING* . . . IN *PERFORMANCE* . . . *ADAPTABILITY*

The above installation represents not only new designing to meet the requirements of the Petroleum and Chemical Industries, but is the results of 10 years of research and testing to meet the trends towards higher efficiency in Cooling Tower performance with increased temperature ranges and closer approach to the ambient wet bulb temperature. Water Cooling Equipment Company Engineers have created the above Multi-Stage Cooling Tower which attacks a hard cooling condition and solves the problem by breaking it into easier cooling conditions which are easier to accomplish. It is, in effect, two or more Cooling Towers operating in series within a SINGLE enclosure and operated with a SINGLE pumping of the water. The internal arrangement provides the serial flow of all the water from one bank of Filling to another, permitting intimate contact with separate streams of outside ambient air in counterflow through each bank. The IMPORTANT factor in this Cooling Tower is . . a high water-to-air ratio is maintained making it possible to increase greatly the enthalpy of the outgoing air over that even theoretically possible with the single pass arrangement in either counterflow or cross-flow Cooling Towers. This is an engineering triumph.

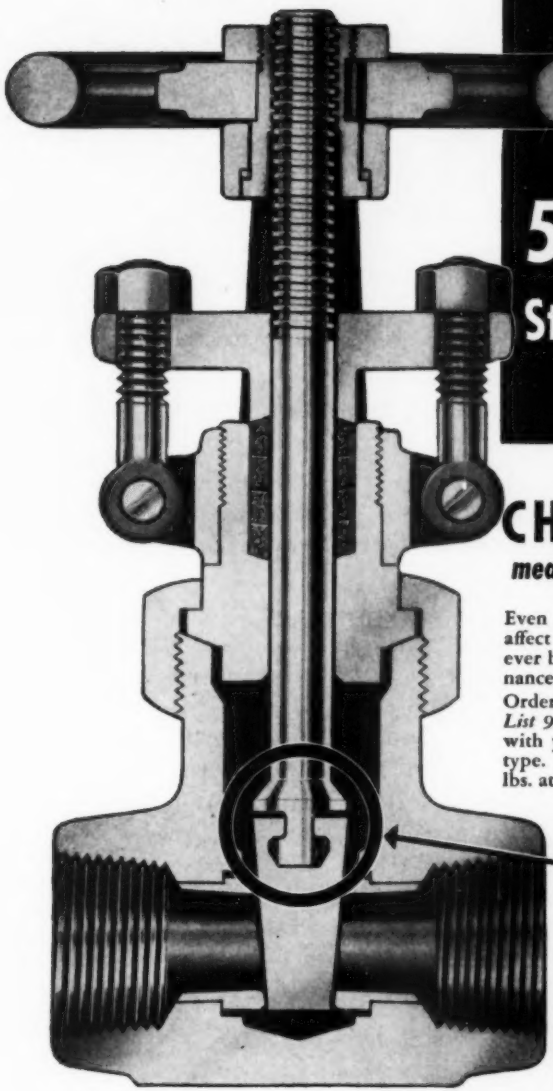
TODAY'S WATER COOLING PROBLEMS CANNOT BE SOLVED WITH YESTERDAY'S METHODS

WATER COOLING EQUIPMENT CO.

NEW HAMPSHIRE & FRISCO TRACKS • ST. LOUIS 23, MO.

FULL INFORMATION UPON REQUEST

NEW DESIGN FEATURE!



50% STRONGER
Stem and Wedge Gate Connection

OF CHAPMAN LIST 960
means Lower Maintenance Costs for you

Even your most extreme operating conditions won't affect this newly designed List 960. It's tougher than ever before. Built to dramatically reduce your maintenance costs.

Order today so you can *check this extra-toughness of the List 960 for yourself.* Available ¼" to 2"... rising stem with yoke (as illustrated). Or rising stem inside screw type. For pressure range 2000 lbs. at 100 deg. F., 380 lbs. at 1000 deg. F. Specify List 990 for higher pressures.

NEW DESIGN...compensates at points where excessive strain can develop... gives 50% stronger stem and wedge gate connection

PLUS... extra wear resistance from heat-treated seat rings and wedge faces hardened to 800 Brinell by exclusive Malcomizing Process

The Chapman Valve Mfg. Co., Indian Orchard, Massachusetts

Maximum Catalyst Utilization with

DA-1®

Davison Fluid Synthetic Cracking Catalyst

. . . is assured by Davison's close laboratory control of production to maintain a high standard of uniformity in physical, chemical and catalytic characteristics. DA-1 is available as . . .

F-1, FINE GRIND; C-1, INTERMEDIATE GRIND; C-2, COARSE GRIND

Already the most widely used catalyst of this type, DA-1 is rapidly being adopted by more and more refineries for maximum efficiency and economy in operation and to profit by the benefits offered by Davison's . . .

FACILITIES—Plants, strategically located in Baltimore and Cincinnati assure you of fast service from established source of supply.

EXPERIENCE—You receive the benefits of our experience as the oldest producer of fluid synthetic cracking catalysts.

SERVICE—Davison service includes our laboratory facilities for catalyst evaluation and trouble-shooting.

For special processes, consult Davison for the development of special catalysts in fluidized, granulated or pelleted form. Write for information and specifications.

THE DAVISON CHEMICAL CORPORATION

Progress through Chemistry

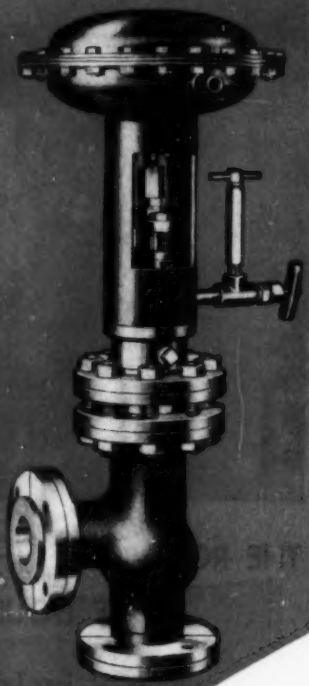
BALTIMORE-3, MD.

AUTOMATIC CONTROL EQUIPMENT

ENGINEERED DESIGN BY **HAMMEL-DAHL**

7000 SERIES

VENTURIFLO® ANGLE VALVE



Applications

They are designed for erosive or high pressure drop applications; for handling slurry; for high pressure and high temperature cracking still operation under coking conditions; for flashing fluids.

Design Features

Bodies available in barstock and cast bowl design • Venturi plug, bushing guided over 5 plug diameters • Venturi seat is an actual section of a Venturi throat and is retained by the bolting of line flanges • Oversized **ALLSTEEL** Superstructure is standard construction.

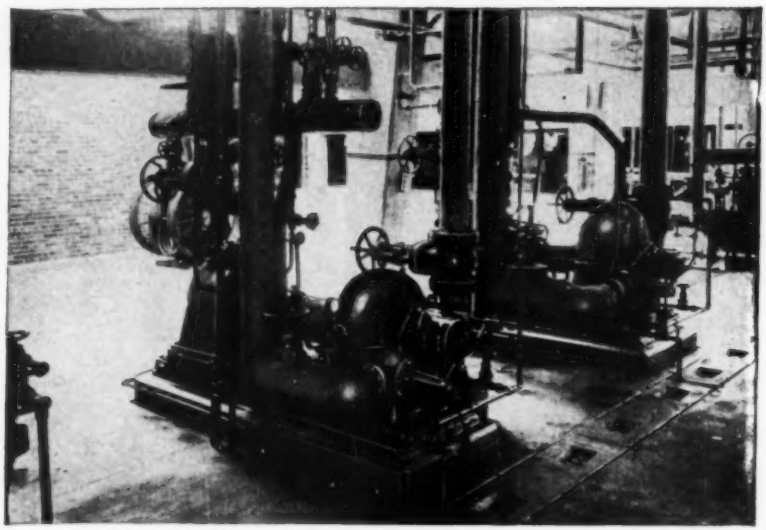
HAMMEL-DAHL COMPANY

243 RICHMOND STREET, PROVIDENCE 3, R. I., U.S.A.

ALBANY BOSTON BUFFALO CHICAGO CINCINNATI CLEVELAND DETROIT
HOUSTON KINGSPORT, TENN. LOS ANGELES NEW YORK PITTSBURGH SAN FRANCISCO
SEATTLE ST. LOUIS SYRACUSE TOLEDO TULSA WILMINGTON, DEL.

In Canada, Railway & Power Engineering Corporation, Ltd.

TERRY



THE ROTORS OF THESE 75 H. P. TERRY TURBINES ARE DOUBLE RIM PROTECTED

The two 75 H.P. Terry Turbines shown above (in the plant of a leading refiner) employ the Terry Solid Wheel Rotor. The wheel is made from a single steel forging and the buckets are milled directly into the wheel. — All as shown in the illustration at the left.

The buckets are protected by rims at the sides of the wheel. These rims would take without damage any rubbing that might occur if the clearance became reduced.

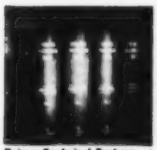
With this construction it is impossible for the blades to foul and frequent inspections of the thrust bearing are not required to obtain safe and dependable operation.

This feature and many others of the Terry Wheel Turbine are fully discussed in our Bulletin S-116.

T-1169

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

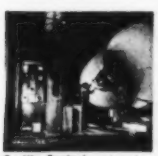
Metallurgical Research conducted continually by recognized specialists who have made major contributions in this field.



Unique Technical Backing of an extensive organization with an international reputation in both process and fabrication engineering.

Complete Facilities for the fabrication of steel products from simple forgings to the most intricate 120 foot towers.

Top Welding Performance assured by specially designed equipment and exclusive employment of master operators.



Quality Control embracing the constant application of the most advanced inspection methods, both visual and non-destructive.

On-Time Delivery made possible by a flexible planning group authorized to re-route work to meet promised dates.

HEAT EXCHANGERS

. . . in ANY quantity for EVERY purpose!

Waste Heat Boilers
General Purpose Exchangers
Condensers

Reflux Sections
Catalyst Coolers
High Pressure Gas Coolers

Gas to Gas
Liquid to Gas

Liquid to Liquid
Fluidized Solid to Liquid

–280°F to +1100°F

High Pressure to Vacuum

In metals, bi-metals, alloys and ceramic combinations

To master temperature, pressure and chemicals use

M. W. KELLOGG

process equipment

See the 1950 Section of the Refinery Catalog for full listing of Kellogg equipment

PRESSURE VESSELS

. . . shipped complete or "knocked-down" for field assembly

Deasphalting Towers and Dewaxing Drums
★
High Vacuum Shells
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Annular Reactors
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Clad Steel Vaporizers

Regenerators
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Coke Drums
★
Fractionation, Absorption and Separation Towers

PIPING, BENDS AND HEADERS

. . . for all process and power applications

★ General Purpose Process Pipe
★ One-piece Giant Bends up to 96" Diameter
An M. W. Kellogg exclusive)
★ Reducing Standpipes
★ Corrugated Nozzles
★ Flanged Bends
★ Corrugated Piping
★ Alloy Headers
★ Diffusion Headers
★ Manifold Headers
★ High Pressure Headers
★ Corrosion Resistant Lined Headers

The M. W. Kellogg Company, Inc. (A Subsidiary of Pullman, Inc.)—Offices in New York, Jersey City, Buffalo, Los Angeles, Tulsa, Houston, Toronto, London and Paris

NOW! END COSTLY

With New, Revolutionary

HAS OVER 1001 PLANT AND PRODUCT USES

Non-Slip . . . Even on Steep Inclines.

Magnification shows even distribution of abrasive grain particles.

Illustrator sills and floors of A. W. ALGRIP afford passengers maximum protection.

Now, for the first time you can cut out the dangerous, costly slipping accidents, that steal thousands of dollars and countless manhours from industry, with A.W. ALGRIP Abrasive Rolled Steel Floor Plate. It's the non-slip floor plate that Safety Engineers, Architects, Railroad Superintendents, Public Utility Managers, Plant Owners and Purchasing Agents have always wanted.

A.W. ALGRIP is made by rolling abrasive grain uniformly as an integral part of the upper portion of steel plate. It retains its non-slip qualities for a lifetime, because as the surface wears, new abrasive particles are constantly exposed. Get more information about this new, "safety" floor plate. Write for booklet or use coupon on opposite page.

A.W. ALGRIP

Product of **ALAN WOOD STEEL COMPANY**

CONSHOHOCKEN 32, PA.

Other Products: Permanent Stainless Clad Steel • A. W. Super-Diamond Floor Plate • Billets • Plates • Sheets • Strip (Alloy and Special Grades)

SLIPPING ACCIDENTS

A.W. ALGRIP The Abrasive Rolled Steel Floor Plate

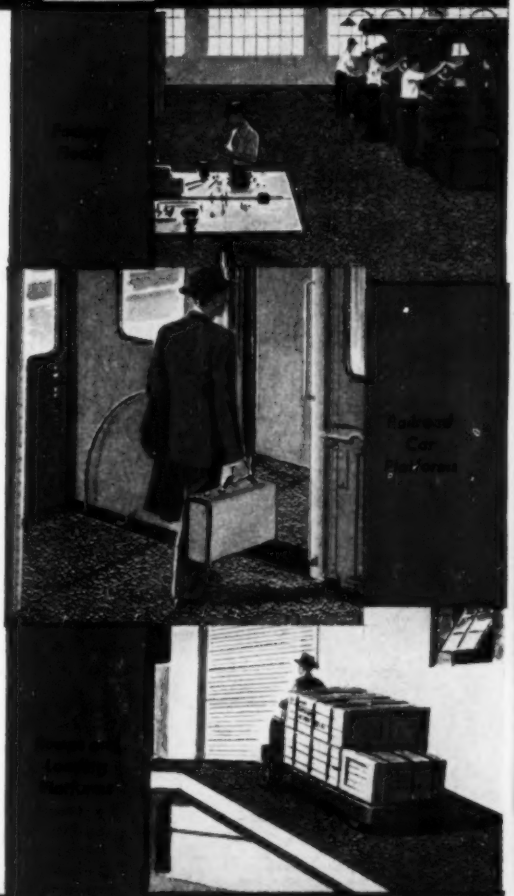
The non-slip properties of A.W. ALGRIP are present under both wet and dry conditions. Slipping is almost impossible as the abrasive particles in A.W. ALGRIP hold fast keeping men's feet safe and secure.

Applications

There are hundreds of "safety" applications for A.W. ALGRIP on railroad rolling stock, aboard ship, on busses, trucks and vehicular equipment.

Power plants, refineries, commercial and industrial buildings also have many applications for A.W. ALGRIP. And this truly non-slip floor plate is ideal for use on ponderous construction equipment, road machinery, concrete mixers and all stationary and mobile structures.

Because A.W. ALGRIP is rolled steel, and, therefore, stronger than other abrasive flooring, thinner sections may be used having greater load carrying capacities.



THERE'S NEVER A SLIP ON **A.W. ALGRIP**

SEND FOR THIS HELPFUL BOOKLET TODAY. USE COUPON.

A.W. ALGRIP ABRASIVE ROLLED STEEL FLOOR PLATE

A Product of **ALAN WOOD STEEL COMPANY**

CONSHOHOCKEN 32, PA.

Gentlemen: I am interested in A. W. ALGRIP. Please send me your 8-Page Booklet.

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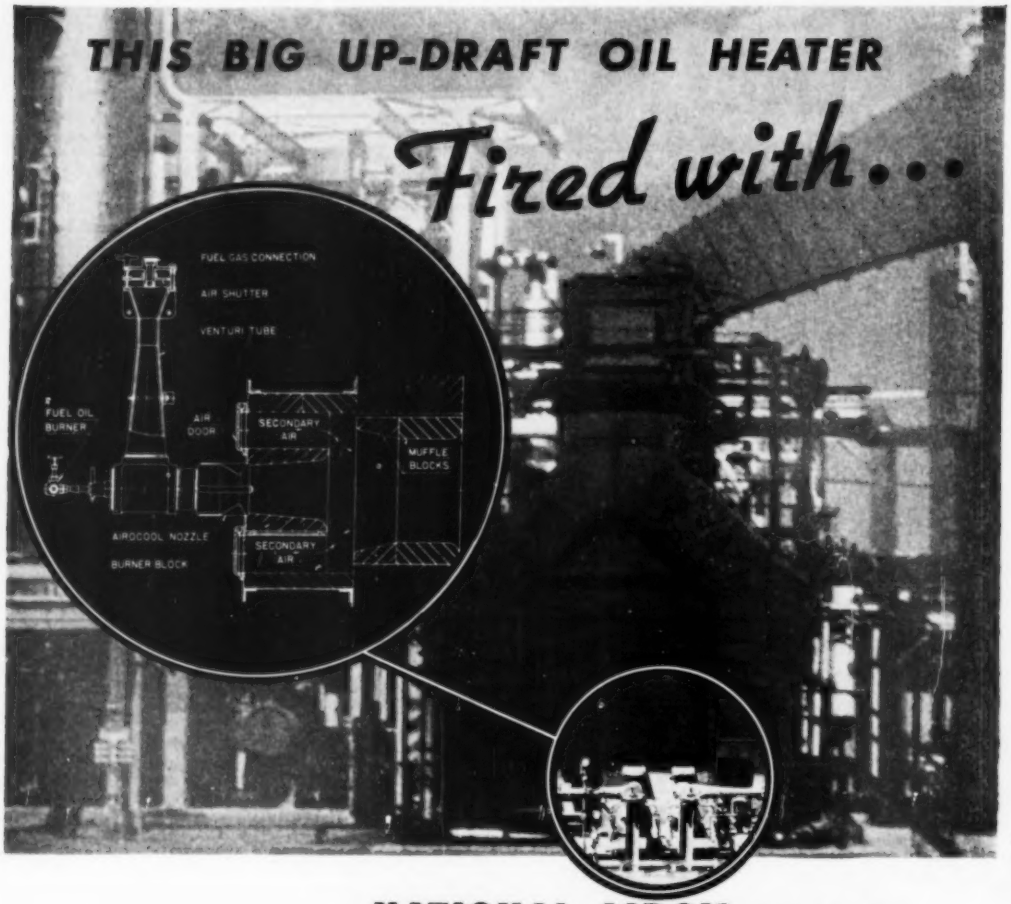
NEW NEW NEW

THIS BIG UP-DRAFT OIL HEATER

Fired with...



NATIONAL AIROIL OIL-GAS TANDEM COMBUSTION UNITS

This shows a large (U.O.P. designed) end-fired up-draft oil heater operating in a new Rocky Mountain refinery. This heater and the others in the same refinery are fired by "National Airoil" TANDEM COMBUSTION UNITS . . . which burn both oil and gas fuels to obtain uniform flame distribution without impingement on heat absorbing surfaces.

The TANDEM COMBUSTION UNIT is also designed for firing both fuels vertically upward. It has a high turn-down ratio with a steady flame . . . maintains a high flame temperature with either oil or gas fuels . . . can be brought quickly to full capacity with a clean flame.

Write for details about the TANDEM COMBUSTION UNIT and the various types available.

OIL BURNERS and **GAS BURNERS** for industrial power, process and heating purposes; **STEAM ATOMIZING OIL BURNERS; MOTOR-DRIVEN ROTARY OIL BURNERS; MECHANICAL PRESSURE ATOMIZING OIL BURNERS; LOW AIR PRESSURE OIL BURNERS; GAS BURNERS; COMBINATION GAS and OIL BURNERS; AUTOMATIC OIL BURNERS,** for small process furnaces and heating plants; **FUEL OIL HEATERS; FUEL OIL PUMPING and HEATING UNITS; FURNACE RELIEF DOORS; AIR INTAKE DOORS; OBSERVATION PORTS; SPECIAL REFRACTORY SHAPES.**

NATIONAL AIROIL BURNER CO., INC.

Main Offices & Factory: **1254 EAST SEDGLEY AVENUE, PHILADELPHIA 34, PA.**

Southwestern Division: 2512 South Boulevard, Houston 6, Texas

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

SYMBOL OF ASSURANCE

J.F. Pritchard & Co.

ENGINEERS • CONSTRUCTORS • MANUFACTURERS

for the CHEMICAL, PETROLEUM, GAS & POWER industries

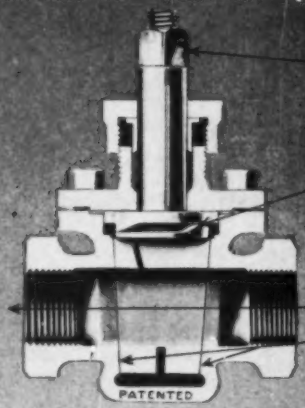
908 Grand Ave. • Kansas City, Missouri

Offices in Principal Cities from Coast to Coast

Preferred for over 50 Years for...

LOW FIRST-COST
LOW MAINTENANCE
LONG SERVICE

and Quick, Positive Operation



1. Quarter-Turn fully opens or closes.

2. Cam serves as positive stop, and automatically seals valve against leakage by pressing seating surfaces firmly together.

3. Straight-line fluid flow. Minimum pressure drop.

4. Seating surfaces protected in both open and closed positions.

5. Homestead Cam-Seald Quarter-Turn Valves are made in straight-way, 3-way and 4-way types, and in metals for most valve needs; for pressures to 3,000 pounds, and temperatures to 750° F.

Besides being the most economical, maintenance-free, long service valves for handling air, water, gas, oil and other fluids, Homestead Quarter-turn valves are unsurpassed for quick, positive operation. A simple quarter-turn fully opens or closes them; and the patented Homestead cam holds seating surfaces in contact at all times. Seating surfaces are protected in both the open and closed positions so that corrosive fluids or grit cannot cause damage and valve failures. Straight, unobstructed fluid passage assures "full flow" and minimum line pressure drop.

To these important features add the rugged construction typical of all Homestead valves and you have the reason why hundreds of plants in all types of industry have insisted on Homestead Cam-Seald Quarter-Turn Valves for half a century.

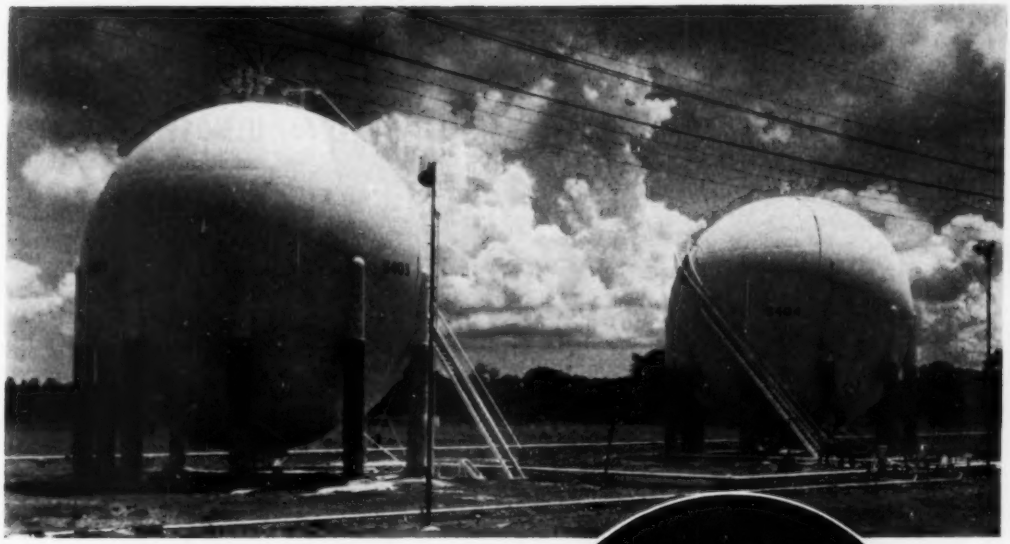
HOMESTEAD Cam-Seald QUARTER-TURN VALVES

For complete information write for Valve Reference Book No. 38.

HOMESTEAD VALVE MFG. COMPANY

"Serving Since 1892"

P. O. BOX 16
CORAOPOLIS, PA.



Above: Two 10,000-bbl. Hortonspheres at the Shell Oil Company's Norco, Louisiana refinery. They are used to store butane under 75 lbs. per square inch pressure.

5 reasons for storing highly volatile products in HORTONSPHERES

1. They provide a means of storing butanes, butane-propane mixtures, and volatile refinery charging stocks in the liquid state. None of the contents of the tank are lost as long as the internal pressure does not exceed the setting of the pressure relief valve.
2. They have a long service life. Corrosion won't attack the inside since oxygen is rarely present in a Hortonsphere.
3. Their maintenance cost is low because the entire structure is supported above the ground on columns, thus making all parts readily accessible for inspection and painting.
4. They reduce the danger of fire because the vapor space in a Hortonsphere contains practically no oxygen at any time.
5. They furnish economical storage. The spherical shape utilizes material to the best advantage resulting in a low annual cost per barrel of storage for liquids requiring pressures of 25 lbs. per sq. in. or more.

Design Pressures and Sizes

The design pressures used for the storage of volatile liquids range from 30 to 150 lbs. per sq. in.

Hortonspheres for gas storage are built for pressures ranging from 20 to 100 lbs. per sq. in.

Standard Capacities

Include units up to 65 ft. in diameter for gases, or 25,000-bbl. capacity for liquids.

Bulletin F contains information on Hortonspheres. Write our nearest office for your copy.

CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

Atlanta 3	2146 Healey Building	Detroit 26	1520 Lafyette Building	Philadelphia 3	1608—1700 Walnut Street Building
Birmingham 1	1548 North Fiftieth Street	Havana	402 Abreu Building	Salt Lake City 1	1531 First Security Bank Building
Boston 10	1030—201 Devonshire Street	Houston 2	2126 National Standard Building	San Francisco 11	1251—22 Battery Street Building
Chicago 4	2463 McCormick Building	Los Angeles 14	1534 General Petroleum Building	Seattle 1	1331 Henry Building
Cleveland 15	2234 Guildhall Building	New York 6	3302—165 Broadway Building	Tulsa 3	1626 Hunt Building

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Constructions Metalliques de Provence, Arles-sur-Rhone, France
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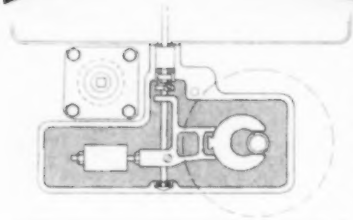
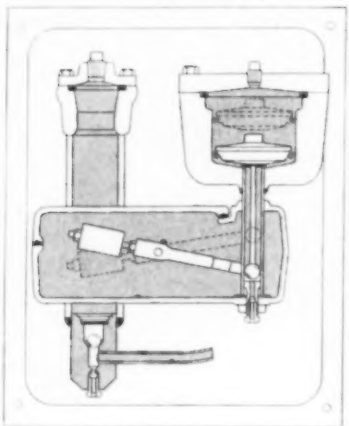
MORE ACCURATE . . . *because it has* MORE POWER *and Less Friction*

The HAYS-PENN MAGNA-CLUTCH MECHANICAL FLOW METER





For HIGHEST ACCURACY

Maximum Power, greatest mercury displacement because of largest float (3.75 in. diam.) and longest float travel (1.5 inches).

Minimum Friction, independent of working pressure because of elimination of pressure-tight bearing, internal knee bearing and shaft end-thrust bearing.

Highest ratio of power to friction.

Precise calibration check at 50 percent of differential available at extra cost.

For LOWEST MAINTENANCE

Manometer accessible without disconnecting piping.

Only one internal moving part (the float).

No bearings to service.

Mercury volume not critical.

Manometer level not critical.

Mercury easily drained.

Positive mercury check valves.

For COMPLETE SAFETY

No leakage possible of inflammable, explosive, or toxic fluids because of no pressure-tight bearings.

For UTMOST FLEXIBILITY

Field adjustable for any differential range:

35" tube from 17" to 35" water
100" tube from 50" to 100" water
200" tube from 100" to 200" water
400" tube from 200" to 400" water
750" tube from 400" to 750" water
1500 or 2500 PSI working pressure

For SPECIAL FEATURES

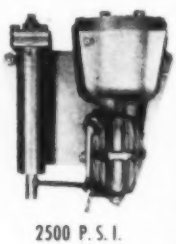
Any meter may be furnished with any or all of the following features:
Dual (wide range) recording pen.
Simple, accurate integrator.
Temperature and or pressure pens.

Worth Reading

THE HAYS CORPORATION
Since '90 COMBUSTION & INDUSTRIAL INSTRUMENTS & CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

HAYS-PENN *Electric* **FLOW METERS**

1000 P. S. I.



2500 P. S. I.

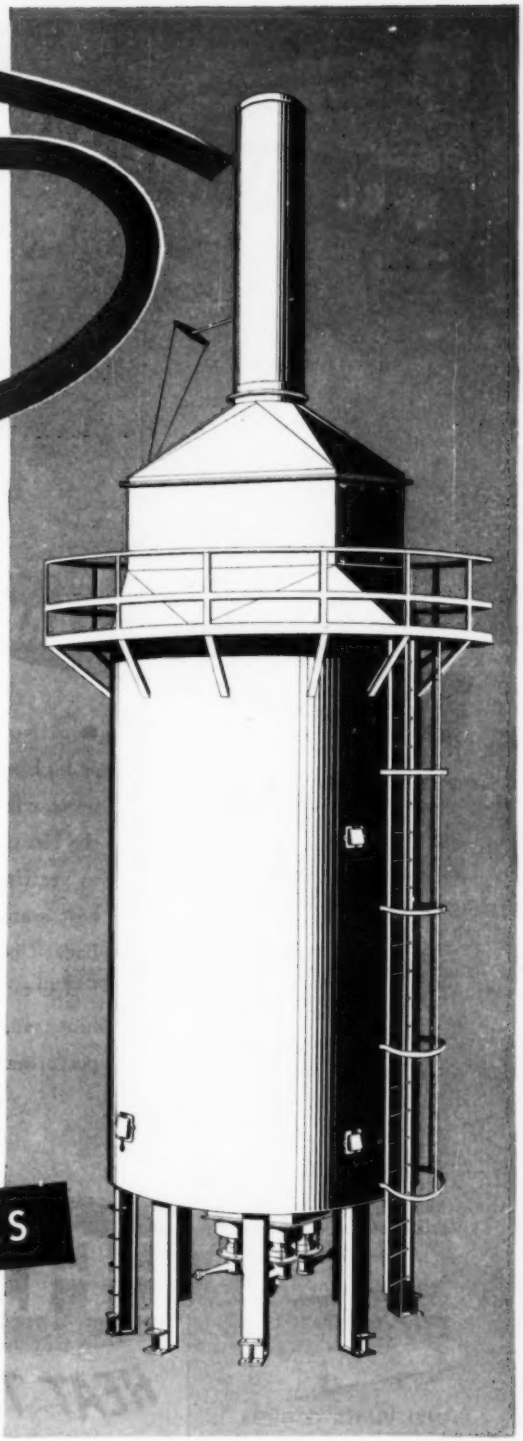
AREA METER 2" and 4"

LOW PRESSURE

SEND FOR BULLETIN 49-915

Heating

by liquid circulation



An efficient, trouble-free system for high temperature heating service

Struthers Wells direct fired systems for heating by liquid circulation have been in use for over sixteen years. This system, including a tubular fired heater and pump circulated heating medium, has proven economical and trouble-free for high temperature heating service.

In addition to the heater, equipment supplied may include all necessary accessories to give a complete installation. Complete temperature control and safety devices are ordinarily included.

The heaters are shop assembled except for the largest sizes.

This equipment is widely used for heating reboilers, grease kettles, and high temperature conversion processes. The same heat transfer medium may be used for cooling if required in a batch process. The heater may also be used in services such as rich oil heating in gasoline plant work.

Heaters are available in a wide range of standard sizes, including small units for pilot plant operation. The equipment is supplied in all radiant design, or with extended surface convection section to give high thermal efficiencies.

Bulletin A-45 describing this equipment is available on request.

Struthers Wells

STRUTHERS WELLS

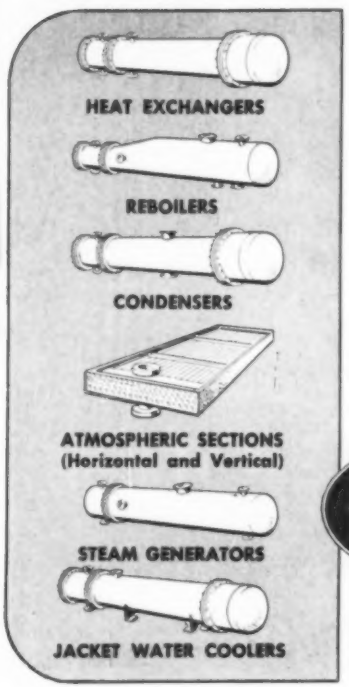
CORPORATION

Process Equipment Department

WARREN, PENNA.

PLANTS AT WARREN, PENNA. • TITUSVILLE, PENNA.

OFFICES IN PRINCIPAL CITIES



● If your problem is the poor performance or high maintenance cost of your heat transfer units, consult an EFCO engineer. He will help you decide the changes or modifications necessary to get the desired performance from your heat transfer equipment.

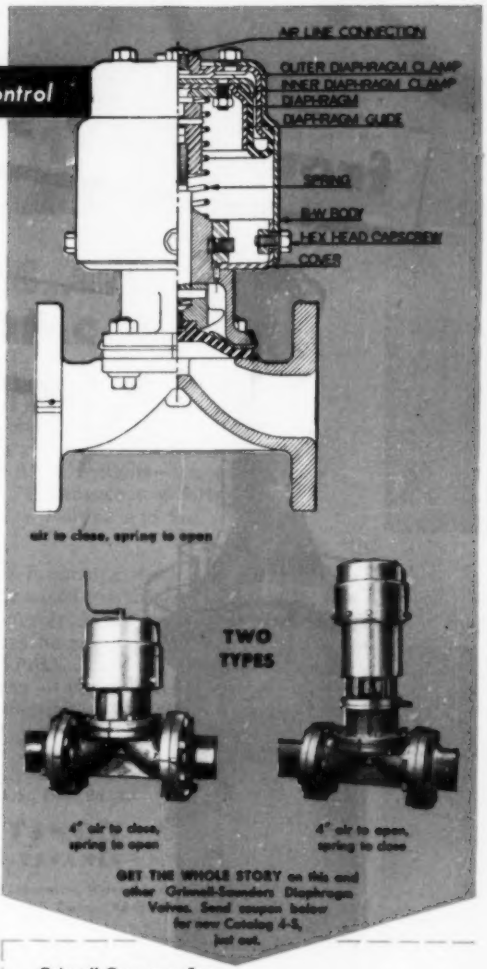
Backed by knowledge and experience, EFCO engineers are constantly working to produce heat transfer units that will give efficient performance and long, trouble-free operation.

ENGINEERS & FABRICATORS, INC.
P. O. Box 7395 Houston 8, Texas

EFCO
HEAT TRANSFER EQUIPMENT

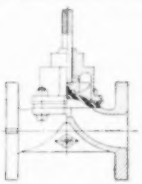
NEW! Grinnell-Saunders Diaphragm Valves *power operated* by Bendix-Westinghouse Rotochambers

dependable power operation and remote control


AIR LINE CONNECTION
OUTER DIAPHRAGM CLAMP
INNER DIAPHRAGM CLAMP
DIAPHRAGM
DIAPHRAGM GUIDE
SPRING
BAW BODY
HEX HEAD CAPSCREW
COVER
air to close, spring to open
TWO TYPES
4" air to close, spring to open
4" air to open, spring to close
GET THE WHOLE STORY on this and other Grinnell-Saunders Diaphragm Valves. Send coupon below for new Catalog 4-S, just out.

FEATURES:

- Bendix-Westinghouse Rotochamber top-works has rolling sleeve type of seal . . . leakproof and practically frictionless. No packing glands and no lubrication required.
- Pressed steel cylinder is neat looking, light and compact. Height of 2" flanged air-to-close valve from center line to top is only 9¾"; air-to-open valve (in open position) is 14⅛".
- Bendix-Westinghouse top-works has been tested up to seven million strokes without any sign of wear or failure.
- Top-works may be operated with air or hydraulic pressures up to 105 pounds. For pressures up to 100 pounds in the line being controlled, an actuating pressure of only 50 pounds is required under average conditions. Pressure reducing valves are not required for pressures up to 105 pounds because of adjustable stem travel stops incorporated in the valve bonnet design.
- Adjustment is easily made without removal of top-works from valve body.



Sliding stem bonnet assembly is suitable for use with other valve motor units. Sliding stem bonnets are interchangeable with other bonnet designs.

YOU GET THESE ADVANTAGES IN ANY GRINNELL-SAUNDERS DIAPHRAGM VALVE: Diaphragm isolates working parts from the fluid, preventing corrosion of these parts and contamination of the fluid; diaphragm opens wide for streamlined flow; diaphragm presses tight for positive closure, even with suspended solids in the line; body, lining and diaphragm materials to meet service conditions; simple maintenance.

Grinnell Company, Inc.
278 West Exchange St.
Providence 1, R. I.

Please send me a copy of your new Catalog 4-S of Grinnell-Saunders Diaphragm Valves.

Name .....

Company .....

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99 YEARS PIPING

GRINNELL

Everything

from alloy studs

to furnaces

That's covering quite a lot of territory. But our refinery stocks are so well selected that you can get what you want merely by phoning us.

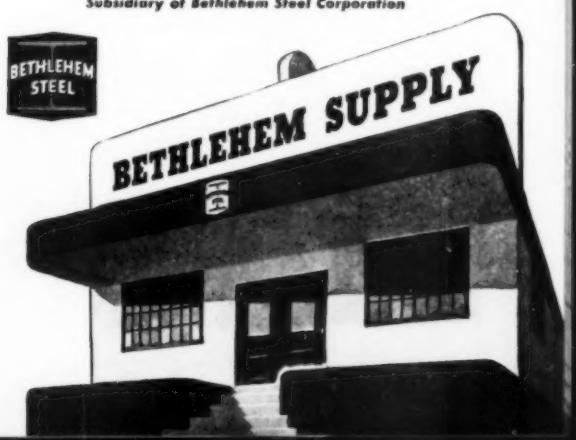
Studs and nuts, valves, fittings, hose and packing, tubular goods, expansion joints, gages, thermometers, regulators . . . these and many other commonly-needed products are available at the nearest Bethlehem Supply store. And, if it's an engineered item—such as a pump or a furnace—we can help you determine the unit that will do the best job; save you the time and expense of running it down yourself.

Maybe all you need today is some studs. Or maybe you're figuring something big, like an Iso-Flow heater. Whether it's big or little or in between, get Bethlehem Supply on the job.

BETHLEHEM SUPPLY COMPANY

General Offices: 21 E. Second St., Tulsa, Okla.

Subsidiary of Bethlehem Steel Corporation



HEADQUARTERS for REFINERY SUPPLIES

For OUT-SIDING...IN-SIDING...and CEILING, too

K&M "Century" APAC filled the bill

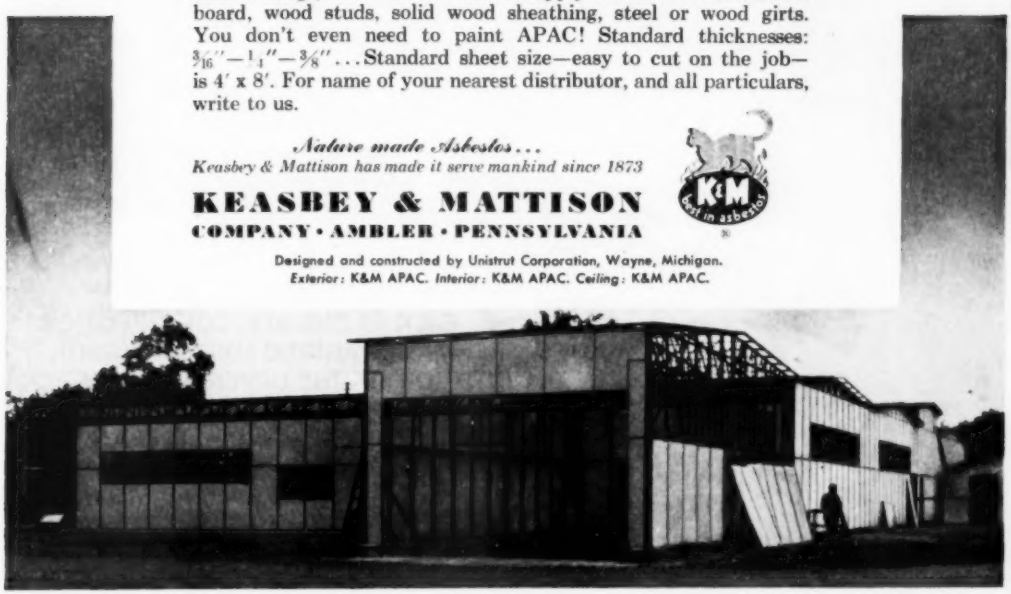
The total bill for the job was held down by the K&M APAC Asbestos-Cement sheets used for all walls and the ceiling of this serviceable structure. And no bill for APAC maintenance is ever even likely. The same sort of economy goes with K&M APAC on any project. Enclosure is quicker because APAC sections—large, strong, but not bulky—are easy to handle. Permanence is as certain as it can be made by a material that defies weather and fire, rust and rot, rodents and termites.

The K&M APAC Asbestos-Cement formula gives you a tough, attractive, money-saving material for panels, partitions, sheathing, shaft casings, bins—all flat areas. Apply APAC over insulation board, wood studs, solid wood sheathing, steel or wood girts. You don't even need to paint APAC! Standard thicknesses: $\frac{3}{16}$"—$\frac{1}{4}$"—$\frac{3}{8}$"...Standard sheet size—easy to cut on the job—is 4' x 8'. For name of your nearest distributor, and all particulars, write to us.

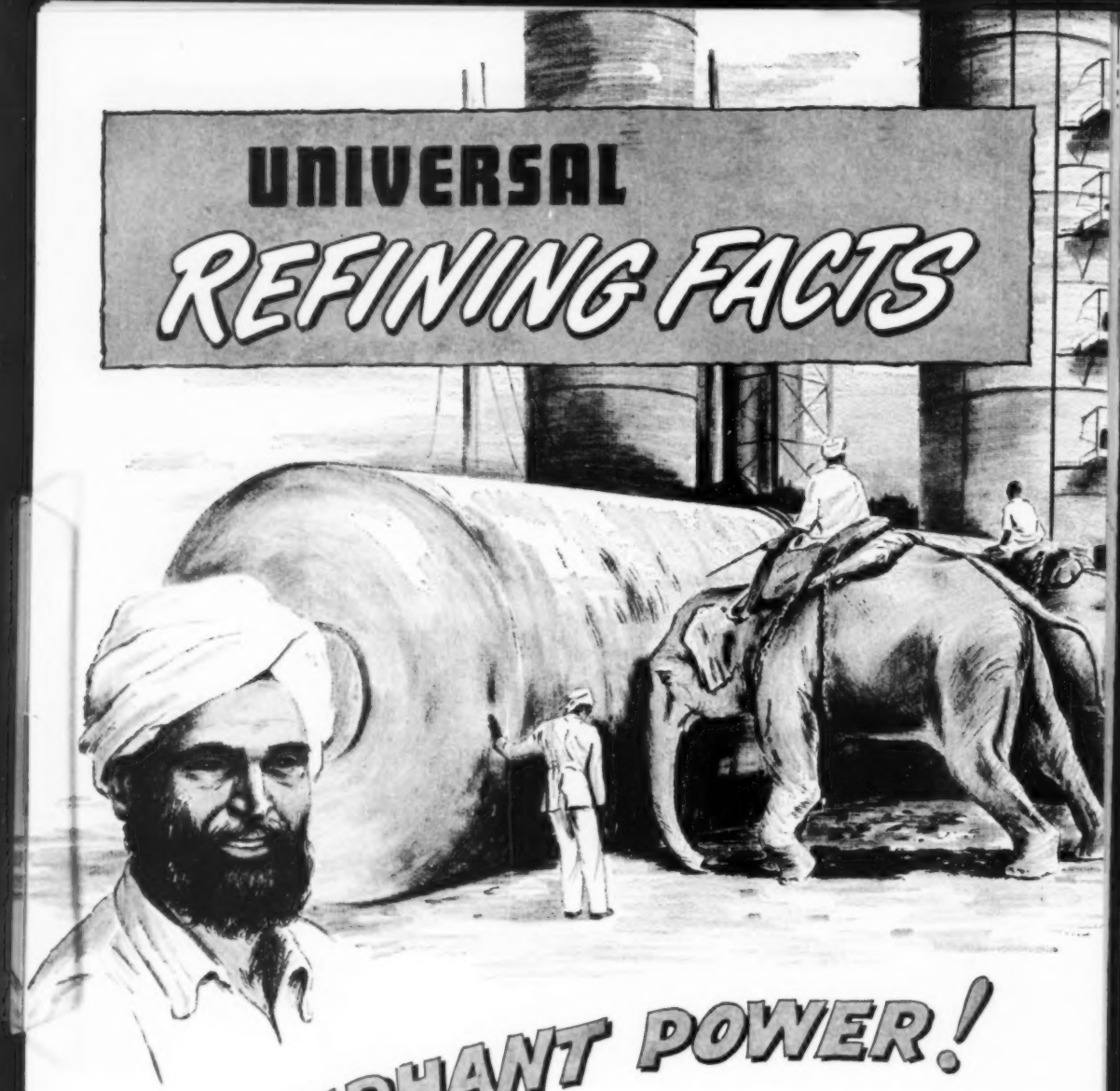
Nature made Asbestos...
Keasbey & Mattison has made it serve mankind since 1873

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

Designed and constructed by Unistrut Corporation, Wayne, Michigan.
Exterior: K&M APAC. *Interior:* K&M APAC. *Ceiling:* K&M APAC.



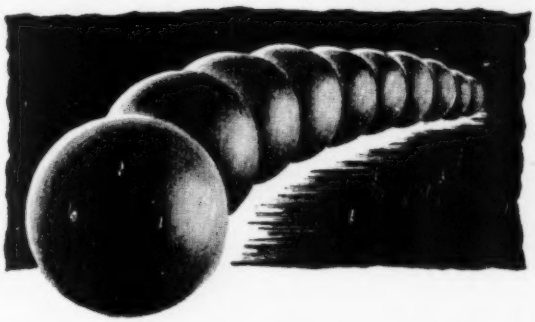
UNIVERSAL REFINING FACTS



ELEPHANT POWER!

BACK IN THE 30's, CONSTRUCTION OF A THERMAL CRACKING UNIT AT DIGBOI, DEEP IN THE INTERIOR OF THE UPPER ASSAM REGION OF INDIA, CALLED FOR INGENUITY AND THE BEST USE OF FACILITIES AT HAND...ELEPHANT POWER IN THIS CASE. WHATEVER THE SITUATION, YOU WILL FIND UNIVERSAL SPECIALISTS MAKING EVERY EFFORT TO KEEP YOUR OPERATION MOVING ECONOMICALLY AND EFFICIENTLY.

THAT'S WHAT ONE EASTERN MARKETER TAGGED A TANKER LOAD OF CALIFORNIA CRACKED GASOLINE. HE THOUGHT IT WOULDN'T SELL ALONG SIDE OF STRAIGHT RUN WHITE GAS. IMAGINE HIS EMBARRASSMENT WHEN CUSTOMERS ASKED FOR MORE AND HIS NEXT TANKER ARRIVED WITH WATER WHITE STRAIGHT RUN. BUT "GOLDEN GAS" WAS PERFORMANCE PROVED. UNIVERSAL WAS AMONG THE FIRST TO URGE THE SALE OF CRACKED GASOLINE WITHOUT EXPENSIVE SULPHURIC ACID TREATMENT.



CUTTING CORNERS!

UNIVERSAL'S M-S (MICROSPHERICAL) CATALYST AVOIDS THE SHARP CORNERS AND IRREGULARITIES THAT CAUSE EROSION OF VESSELS AND PIPING AS WELL AS CATALYST LOSS THROUGH ATTRITION. ONLY 70 MICRONS (AVERAGE) IN DIAMETER, M-S LOOKS LIKE A FINE POWDER TO THE NAKED EYE... BALL BEARINGS THROUGH A MICROSCOPE.

OIL IS PROGRESS!

125 MILLION DOLLARS IS SPENT EACH YEAR BY U.S. OIL COMPANIES FOR RESEARCH... AND TEN THOUSAND PEOPLE ARE EMPLOYED BY THESE COMPANIES FOR THIS PURPOSE ALONE.

UNIVERSAL OIL PRODUCTS COMPANY

UOP General Offices: 310 S. MICHIGAN AVE., CHICAGO 4, ILLINOIS, U. S. A.

LABORATORIES: RIVERSIDE, ILLINOIS

Universal Service Protects Your Refinery

for
SERVICE
you can always depend on...
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NORVELL-WILDER
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Quick service and complete stock SAVE YOU TIME and MONEY

NORVELL-WILDER
SUPPLY COMPANY

General Offices at Beaumont

LIGHTNING PRODUCES FERTILIZER, TOO

Nature's fireworks—by transforming the inert nitrogen in the air to nitric acid — produce much more fertilizer per year than do Chemico-built plants. But lightning scatters its benefits without consideration for those who need them. Chemico-built plants, on the other hand, produce the kind of commercial fertilizer you want . . . where you want it . . . when you want it . . . in the concentration you want . . . at a very reasonable price.

Chemico offers a complete engineering and contracting service to the fertilizer industry, ranging from the design and construction of complete fertilizer works to furnishing small individual units and auxiliary plants of a specialized nature. From Pittsburgh to Pakistan, from Colombia to China, Chemico has been building such plants since 1914. Chemico brings to each new project a wealth of experience, proven methods and guaranteed performance.

If your plans include the production of nitrates, superphosphates, double superphosphates, ammonium phosphates, mixed salts or any other commercial fertilizers, it will pay you to discuss your specific problems with Chemico.

CHEMICAL CONSTRUCTION CORPORATION

EMPIRE STATE BLDG., 350 FIFTH AVENUE, NEW YORK 1, N. Y.

EUROPEAN TECHNICAL REPRESENTATIVE
CYANAMID PRODUCTS LTD., BRETTENHAM HOUSE, LANCASTER PLACE, LONDON W. C. 2, ENGLAND
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CHEMICO
CHEMICAL CONSTRUCTION CORP.

Chemico plants are profitable investments

NEW

SERIES 12100*

FORGED STEEL

DROP

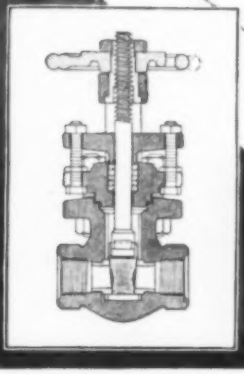
Vogt

BOLTED BONNET
BOLTED GLAND

150-800 POUND

GATE VALVES

SIZES 1/4" to 2"



***Series 12100**

CARBON STEEL } 800 Pounds @ 750° F.
1500 Pounds Cold Non-Shock

For 150-800 pounds service • Round Bolted Bonnet • Bolted Gland • Gasket or Ground Joint • Outside Screw and Yoke • Renewable Seat Rings • Solid Wedge — Slotted Type • Rising Stem 11½-13% Chrome Stainless Steel Trimmings • Sizes 1/4" to 2" inclusive.

HENRY VOGT MACHINE CO. Louisville 10, Ky.

BRANCH OFFICES: NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • ST. LOUIS • DALLAS

Controlled Quality

gives you steel heat code protection

ON EVERY FITTING AND FLANGE IN THE COMPLETE LADISH LINE

Pioneered by Ladish . . . and long recognized as its symbol of Controlled Quality . . . the Ladish steel heat code is visible evidence of added reliability resulting from metallurgical integrity. It protects you with certified laboratory reports always available giving specific test data as proof that all requirements of standard or special specifications are met or exceeded.

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A COMPLETE LINE PRODUCED UNDER ONE ROOF
. . . ONE RESPONSIBILITY

LADISH CO.

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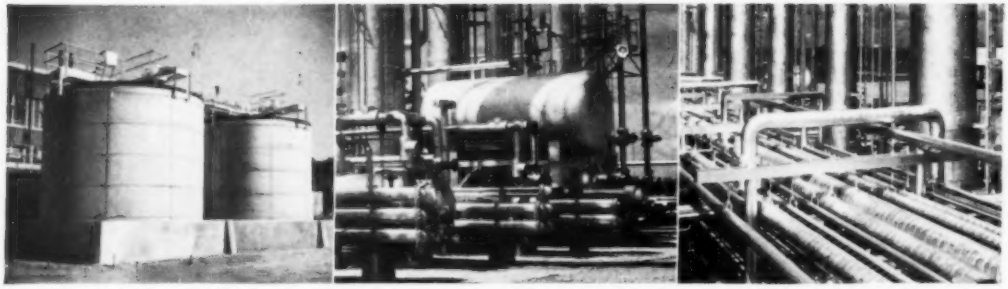
THE FITTINGS LINE INCLUDING CARBON, ALLOY AND STAINLESS STEELS, ALUMINUM, BRASS AND COPPER

THAT IS COMPLETE IN TYPES, SIZE RANGES AND MATERIALS

Why ZEROLITE is the outstanding cold insulation...



. . . for tanks **. . . equipment** **. . . pipes**

Here are 4 outstanding qualities which make this new *inorganic* insulation the choice for so many low temperature services: (1) high fire resistance (2) low heat conductivity (3) excellent moisture resistance (4) immunity to attack and damage by many solvents.

Because of these advantages Zerolite* is particularly recommended for locations where the fire problem is dominant; where solvent fumes may cause costly deterioration of an insulation, and where low heat conductivity is essential in systems working at temperatures as low as minus 400F.

Zerolite is made from mineral wool processed with a special binder to make it exceptionally resistant to moisture. It is manufactured in sheet, lagging and pipe insulation form . . . in a variety of sizes and thicknesses. The pipe insulations are further protected with an asphalt saturated asbestos felt which reduces the need for seam filling and speeds installation.

Reg. U. S. Pat. Off.

ZEROLITE IS RECOMMENDED FOR:

- Petroleum dewaxing equipment
- Gas purifiers and condensers
- Chillers and exchangers
- Chemical process lines
- Pharmaceutical process equipment
- Reactors and economizers
- Solvent storage and piping
- Ammonia lines
- Cold tanks and vessels
- Cold water lines
- Freon lines
- Air conditioning equipment

SEND FOR FOLDER

A copy of this new Zerolite folder is yours for the asking. Write Johns-Manville, Box 290, New York 16, N. Y.

Johns-Manville **ZEROLITE**

REFRIGERATION INSULATION

THINGS YOU CAN'T CALCULATE ON YOUR SLIDE RULE

OTHER GENERAL AMERICAN EQUIPMENT

TANKS
WATER
GASOLINE
ACID
PROPANE
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CHLORINE
BLENDING
MIXING
CRUDE

TOWERS
ABSORBER
BUBBLE
FLASH
VACUUM
FRACTIONATING
PRESSURE

DEWAXING FILTERS
TURBO-TREATERS
STEEL PLATE FABRICATION
WIGGINS ROOFS

Engineering problems solved in the laboratory are problems no longer — yet in steel and alloy plate fabrication there are factors where the right answers yield more readily to common sense than to the slide rule.

The integration of planning, design, fabrication and erection into one responsibility—the full utilization of laboratory and X-ray equipment—the desire to maintain an established reputation painstakingly built up over the years — the "know how" born of operating the world's largest privately owned tank car lines—all of these things are considerations you can't possibly calculate on your slide rule.

As a matter of fact, from the very first moment you begin to think about steel and alloy plate fabrication, it's common sense to think about the General American Plate & Welding Division.

GENERAL AMERICAN TRANSPORTATION CORPORATION

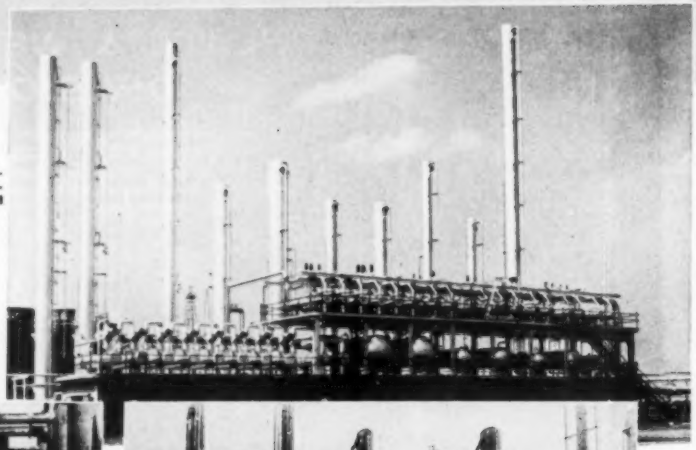
Plate & Welding Division

135 SOUTH LA SALLE STREET, CHICAGO 90, ILLINOIS

WORKS: Sharon, Pa., East Chicago, Ind.

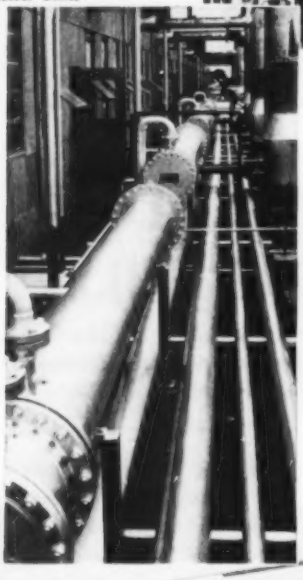
PLATE & WELDING DIVISION GENERAL AMERICAN TRADE MARK

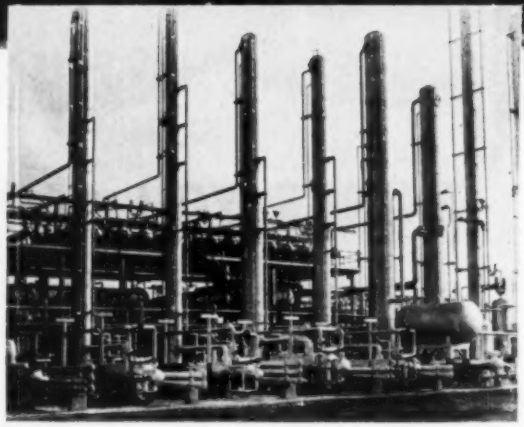
OFFICES: New York, Cleveland, Louisville, Orlando, Pittsburgh, St. Louis, Sharon, Washington, D. C.



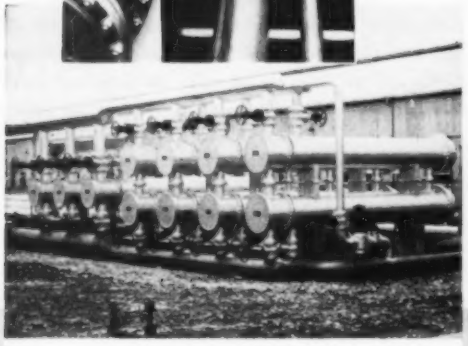
Batteries of G-R Main Still, Primary Still, Deethanizer, Debutanizer, Depentanizer, and Splitter Condensers.

G-R Jacket Water Coolers for Power Cylinders and Compressor Cylinders of Diesel Engine-driven Compressor Units.

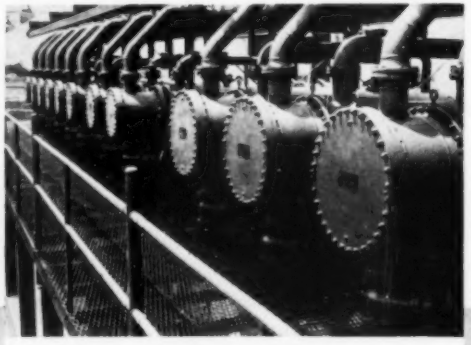




Group of G-R U-Tube Reboilers, and stacks of G-R Twin G-Fin Sections serving as Feed Exchangers and Product Coolers.



Some of the G-R Lube Oil Coolers for the Compressor Units.



Close-up View of the stationary head ends of some of the G-R Condensers shown in illustration at upper right.

GRISCOM-RUSSELL: PIONEERS IN HEAT TRANSFER APPARATUS

NINETY FIVE
G-R UNITS
ON 37 DIFFERENT
HEAT TRANSFER SERVICES
at Stanolind's New Hastings Plant

The Hastings gasoline recovery plant of Stanolind Oil & Gas Company at Alvin, Texas, is one of the many important modern projects in the petroleum industry for which maximum effectiveness and economy of heat transfer are assured by G-R equipment.

The great variety of G-R equipment at this plant, as listed in the column at the right, is significant to you. It means that G-R can furnish exactly the correct type of unit for *any* and *every* heat transfer service. No matter what may be *your* needs for heaters, coolers, condensers or heat exchangers . . . in standard or special designs . . . for moderate or severe requirements . . . you can safely depend on the unequalled G-R engineering experience and performance records. Write for bulletins describing G-R equipment for services in which you are interested.

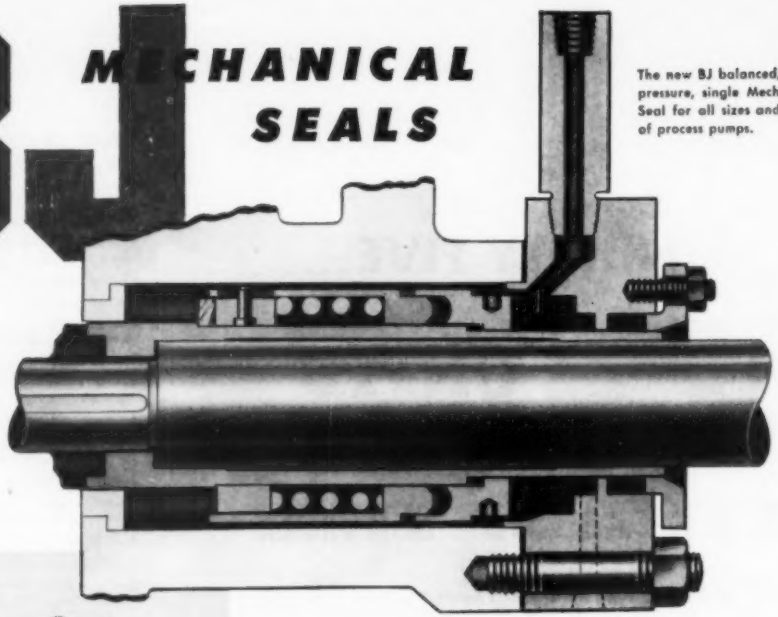
THE GRISCOM-RUSSELL CO.
285 MADISON AVENUE, NEW YORK 17, N. Y.

GRISCOM-RUSSELL

ROSTER OF G-R APPARATUS AT HASTINGS

2—FST Splitter Condensers
2—Twin G-Fin Section Splitter Feed Exchangers
1—CSU Splitter Reboiler
2—FGT Deethanizer Condensers
2—Twin G-Fin Section Deethanizer Feed Exchangers
1—CSU Deethanizer Reboiler
2—FST Depropanizer Condensers
3—Twin G-Fin Section Depropanizer Feed Exchangers
1—CSU Depropanizer Reboiler
2—FGT Debutanizer Condensers
2—Twin G-Fin Section Debutanizer Feed Exchangers
1—CSU Debutanizer Reboiler
2—FST Depentanizer Condensers
2—Twin G-Fin Section Depentanizer Feed Exchangers
1—CSU Depentanizer Reboiler
3—FGT Primary Still Condensers
3—FGT Main Still Condensers
2—Twin G-Fin Section Propane Coolers
1—Twin G-Fin Section Propane Dehydration Regeneration Gas Reheater
1—Twin G-Fin Section Mixed Butane Cooler
3—Twin G-Fin Section Debutanizer Bottom Coolers
2—Twin G-Fin Section Isopentane Final Coolers
3—Twin G-Fin Section Gasoline Coolers
4—FST Rich Oil Preheaters
3—Twin Bare Pipe Section Regeneration Gas Coolers
2—Twin Bare Pipe Section Regeneration Gas Heaters
2—Twin Bare Pipe Section Reabsorber Intercoolers
8—FST Main Oil Exchangers
12—FST Compressor Lube Oil Coolers
8—FST Compressor Jacket Water Exchangers
3—FST Engine Jacket Water Coolers
1—H Bantube Feedwater Evaporator
1—F Drainer
1—K Level Controller
3—Twin Bare Pipe Section Steam Condensate Exchangers
2—Twin Bare Pipe Section Condensate Coolers

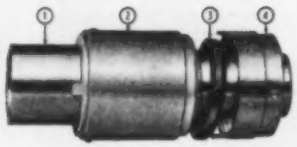
BJ MECHANICAL SEALS



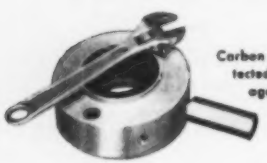
The new BJ balanced, high-pressure, single Mechanical Seal for all sizes and types of process pumps.

beat the STUFFING out of packing costs!

The Type U Mechanical Seal, when constructed of corrosion and heat-resistant materials, is ideal for high temperature service or for pumps handling corrosive liquids at high pressures.



1. Shaft sleeve
2. Spring and Drive assembly
3. "U" Cup
4. Rotating face



Carbon face is protected from damage because it is recessed.

BY INCORPORATING Mechanical Seals, mechanical performance of centrifugal pumps goes up, and because of entirely satisfactory stuffingbox operation, the overall cost is lower. BJ Mechanical Seals are easily assembled units—installed and maintained by your personnel at a much lower cost than the conventional stuffingbox packing.

BJ MECHANICAL SEALS eliminate the frequent expense of replacing packing—eliminate high-pressure-seal oil pumps, control valves, and costly oil seal systems—and prevent the leakage or contamination of pumped liquid.

FIT ALL BJ PUMPS. Three standard types and various materials of construction fit the proper seal to the pressure, temperature and corrosive action of liquids pumped. For complete information on the new BJ Mechanical Seals—write for illustrated bulletin, or ask your local BJ Representative to describe this important stuffingbox development at your convenience.

Byron Jackson Co.

Since 1872

LOS ANGELES 54, CALIFORNIA

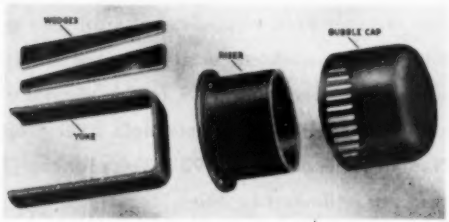
Offices in principal cities • Plants: Los Angeles, Bethlehem, Houston, Fresno

Now YOU CAN

INSTALL OR REMOVE BUBBLE CAPS *FASTER*

the PSC *Way*

Introduced 18 months ago by The Pressed Steel Co., the new LeJons method of assembling bubble caps and risers has substantially shortened the off-stream time required for clean-out and inspection on a "turn around". It has likewise shown impressive savings in tray construction cost.



The above exploded view shows all the parts used in the new LeJons bubble cap assembly. Cap, riser and yoke come securely weld-assembled in one unit, ready for wedging in the tray. To install just hammer in wedges and bend over slightly to lock. To remove, simply knock out wedges. A survey of users shows these seven reasons why this unprecedentedly simple assembly is being increasingly specified:

1) Faster Assembly -- no bolts or nuts.
2) Perfect alignment of caps automatically.
3) Tighter Assembly -- unit locked positively.
4) Stronger Trays, due to wedging action.
5) Eliminates costly flaring or welding of risers.
6) Less Maintenance, due to simplicity and tightness.
7) Ease of Cleanout or Replacement.

Assemblies furnished in any workable metal, style and size of cap. Gages of metal in cap and riser to suit size. Made to suit tray plate thickness with or without gaskets. Yoke of 1/8" metal. Wedges of 12 and 14 gage.

OVER 150 STANDARD STYLES *of bubble caps are furnished* WITHOUT DIE COST

All of the over 150 standard PSC bubble caps are furnished for tray assembly by the LeJons or any other standard method. With dies on hand for this wide choice of styles, The Pressed Steel Co. not only makes prompt delivery, but we save many customers the cost of dies. Send your blueprints. Special caps promptly designed. Let our technical staff aid you. BULLETINS 21 and 31 on request.

LICENSED UNDER PATENT NO. 2480862

THE PRESSED STEEL COMPANY

of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

☆ ☆ ☆ OFFICES IN PRINCIPAL CITIES ☆ ☆ ☆

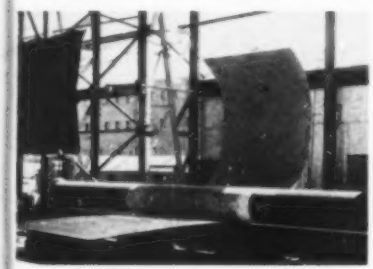
STAINLESS STEEL

STAINLESS STEEL EVAPORATOR AND STACK

- **STAINLESS STEEL VESSELS**
- **STAINLESS STEEL CLAD VESSELS**
- **STAINLESS STEEL LINED VESSELS**

●

Our complete facilities are available for stainless steel fabrication to meet your requirements, regardless of size. The main fractionating column shown above was fabricated from ⅜" plus 5/64" stainless clad steel and are 9 feet in diameter by 124 feet long. Just one of the many stainless steel projects handled at McNamar. Write or call 2-6293 in Tulsa for complete information about our unlimited facilities.

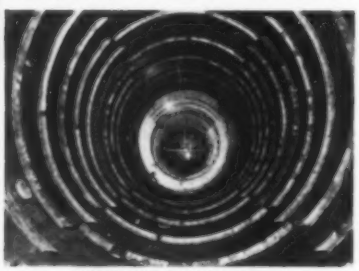


ROLLING STAINLESS STEEL ON OUR LARGE POLLS
(Roll capacity, up to 2" thickness and widths up to 32')

●

McNamar Products

REFINERY TOWERS • STORAGE TANKS • ACCUMULATORS—SEPARATORS • HEAT EXCHANGERS • PIPING—STRUCTURAL SHAPES • MISCELLANEOUS REFINERY VESSELS.



INSTALLING STAINLESS STEEL
TRAY SUPPORT RINGS

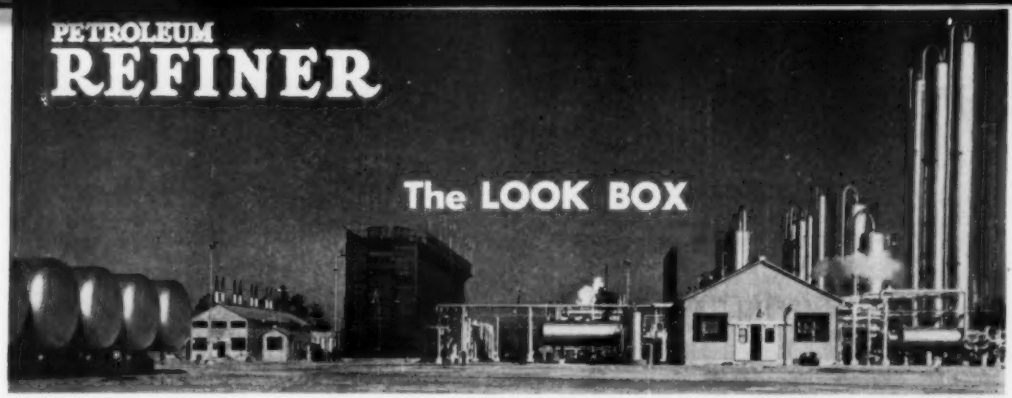
McNamar Facilities

70-TON CRANE • ROLLS 2" PLATE THICKNESS • X-RAY EQUIPMENT • NATIONAL BOARD INSPECTION • AUTOMATIC WELDING • API-ASME CODE WELDING • STRESS RELIEVING SAND BLASTING.

McNamar Boiler & Tank Co.

REFINERY SALES DIVISION • BOX 868 • TULSA, OKLA.

The LOOK BOX



WHEN more than 5000 men from all branches of the petroleum industry swarm into a city for a convention, such as the recent American Petroleum Institute meeting in Chicago, the facilities required begin to get just a little bit cramped. The cramped situation applies not only to the room situation in the immediate vicinity, but to restaurants, coffee shops, meeting rooms, and just plain standing room in the hotel lobby to watch some of the lobbying going on. The officers of the API have recognized that the meetings were growing too large—that too many subjects were brought up for discussion, and that too many committees had to find time to meet on important matters. Also, too many people came to see other people, which was very little help to those trying to maintain a semblance of order.

API Sessions — To Each His Own

But an organization of the industry for the benefit of the industry is not one from which members of the industry can be kept away, if there is the slightest reason for them to attend. There had to be another solution.

The main attraction of the annual meeting was the program. There was too much of it that concerned too many people. This year, the program was cut almost in half. There were fewer sessions devoted to marketing, refining, production—fewer committee meetings were scheduled, and more time was devoted to discussions of problems of policy, economics, and other important matters that effect the petroleum industry generally.

It is not a matter of attending to one thing and letting the others slide for API. The business that could not be attended to at the annual meeting will be handled at the mid-year meetings of the institute. These smaller groups will have ample opportunity to settle down to their committee meetings and hear the technical papers that pertain to their daily jobs without being bothered about why the federal government wants the oil in the Continental Shelf. The first and best example of this split was the mid-year API division of refining meeting held in Houston at the Shamrock last year. This was an excellent meeting and resulted in most of the members going away satisfied that API is a pretty good organization.

The next mid-year refining meeting will be held in Cleveland, Ohio, May 1-4, 1950.

This plan for future API meetings, we predict, will be most successful, especially for the mid-year meetings. The geographic spread obviously keeps many people of the industry from attending the annual meeting, but when the mid-year meeting gets around to their locality, they will be in attendance.

EVER now and then, American management steps upon the rostrum and delivers a speech to the employes in which it is indicated that management has discovered the human relations side of business and intends to do something about it for those human beings who work under management. On the other hand, management changes, and some of these changes give new men with fresh ideas the opportunity to push them across. Usually these men come from the ranks and they are interested in the human relations side of business for another reason—because they have experienced the oppression resulting from the lack of human relations between management and its employes, and want to see it changed.

The Human Relations Side

"Hard-head" is the term used in the refinery which is applied to certain members of management by men who wear hardhats as part of their equipment. It pertains directly to the feeling the employes have for management. It means that management is hard to get along with, that new ideas for better operations, increased production,

PHOTO AT TOP OF PAGE—Gasoline plant operated by American Republics Corporation in the Silsbee field, Hardin County, 25 miles north of Beaumont, Texas, which was completed and placed in operation earlier this year. The plant processes 60 million cubic feet of gas daily and extracts 125,000 gallons daily of liquid hydrocarbons. It also injects gas for cycling and dehydrates residue for pipe line sales.

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better working conditions, etc. are extremely difficult to broach to management—much less put across. There is little friendship between the men of this plant and its management, and there is even less opportunity in this atmosphere for them to get acquainted.

True enough, this situation does not exist in every plant. For that matter, it does not exist in a great many plants—at least not to such an extreme. It does exist, however.

There are two things that an employe can give to management without cost or obligation on the part of management—his idea, which is a product of his thinking on and off the job, and his cooperation on the job. Management can rest assured that if no ideas are received from the employes, it is because they have indicated that they are not receptive to ideas from employes, or else there exists a rift between them, so that an employe feels that it would be a waste of his time. He just works there!

Top management, the "bighead," in a large company, will never have the time to get acquainted with more than a few of the employes in his company. Yet quite often, bighead overlooks the fact that the heads of various departments not only are not acquainted with him, but are not acquainted with each other. Further down the line, the department heads are not well acquainted with the men in their department. The usual reason given for this condition is, "I know him well enough to talk to him about the business." It is difficult to create and maintain an atmosphere of congeniality and cooperation under these conditions.

In an address, "Management's Frontier," before the petroleum division of the AIME in San Antonio, during October, L. F. McCollum, president of Continental Oil Company, Ponca City, Okla., said that the real income of the working man has increased sevenfold over the last 100 years, and that leisure time to enjoy the results of production, once for the privileged few, is now the accepted right of the many. Even so, more and more material things have not brought industrial peace, because the basic human desires of men have not been satisfied.

"We should not be surprised or shocked," he said, "that men refuse to live close to the margin of absolute poverty, as they lived before the industrial revolution and even as late as the nineteenth and early twentieth centuries. They seek freedom from constant fear of dire want. And they want more than that. We are not on this earth just to make things or just to make money. We may enjoy the highest economic standards and the most complete security, but still that will not be enough. We want to express our personalities; to feel important; to be noticed; to be praised when we do a good job; and to be treated as individuals rather than as numbers.

"We also want to feel that we are a part of the society in which we live. We want to be consulted on matters that seriously affect us; we want to have something to say about our own destinies. We all have the same basic feeling, regardless of the rank we may have."

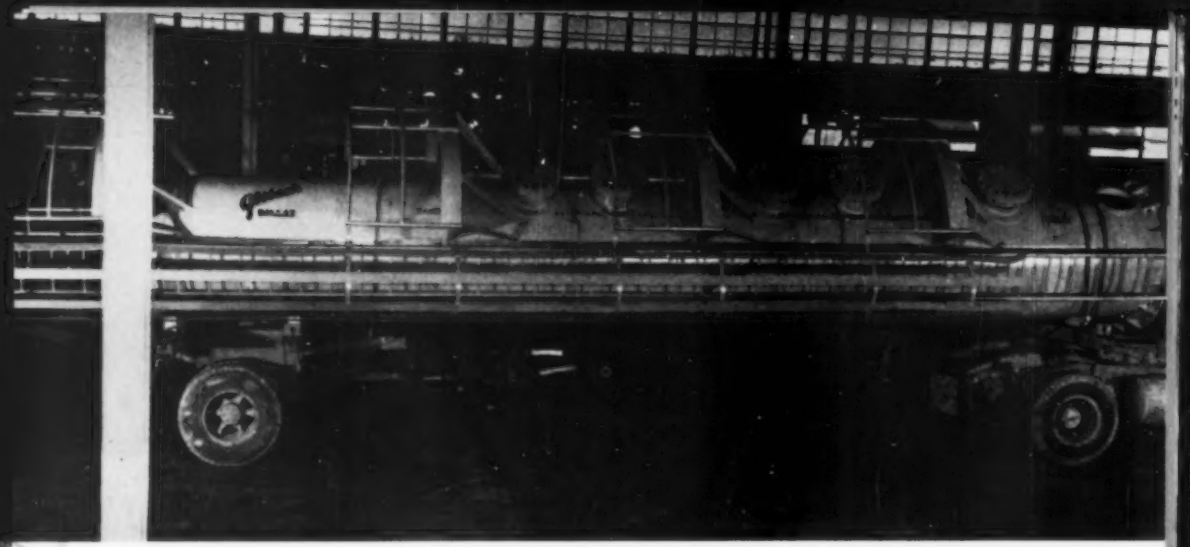
Teamwork Pays Off

IT IS now common knowledge that the diesel motors of freight trucks are able to operate without major overhauls for well over 150,000 miles. Further interesting comment on this subject was heard at the October meeting of the Society of Automotive Engineers in St. Louis. In a paper entitled, "Pioneering of a Diesel Engine for Highway Cargo Transportation," by C. N. Guerasimoff, chief engineer, engine division of The Buda Company, and Adrian Curtis, operations manager of Garrett Freight Lines, Inc., the convention was told that the freight company was currently operating super-charged, smooth-running, powerful diesel engine trucks, which are very popular with their drivers.

The engines develop about 245 horsepower and transport gross loads up to 72,000 pounds on a 3500-mile route in the Western States at a speed of 50 miles per hour. The route runs from sea level in California over summits in excess of 7000 feet. Temperatures range from 35° below zero to desert heat of 120°. The engines average from 140,000 to 150,000 miles on overhauls, and some engines have run as high as 194,000 miles without overhauls.

The freight line reported 0.002 wear in cylinder walls and less than 0.001 to 0.0015 on crankshaft wear. Fuel pumps are re-calibrated and reinstalled on the same engine, accessories are rebuilt, blowers are checked and new seals installed. Pistons are replaced or reclaimed with a 5/32-inch chrome top ring instead of the standard ⅛-inch thick ring. All bearings are replaced after this mileage, the authors said.

This progress was made by manufacturer and operator as team-mates. On the basis of continued cooperation, it is not surprising to hear predictions that future engines are on the threshold of running 250,000 miles without overhauling. In addition, these engines will have a much greater power output and sizably improved fuel economy.



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...for refiners everywhere!

GLITSCH is now engineering and fabricating completely constructed pressure vessels for the oil refining and chemical processing industries . . . companion equipment to the internationally used GLITSCH "Truss-Type" bubble trays, caps and tower internals.

Engineering and purchasing departments have asked for this package unit which combines unified manufacturing responsibility with low cost. And again GLITSCH comes up with the answers.

In a large new modern pressure vessel shop, GLITSCH can fabricate and ship in record time GLITSCH towers with companion trays and caps in any variety, size and quantity . . . as well as tanks and drums for all requirements.

Look to GLITSCH for complete units . . . engineering experience . . . fabrication knowledge . . . complete facilities . . . and low cost. Trained GLITSCH personnel in key cities will plan with you.

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Natural gas pipe line systems, distribution, and marketing arrangements all require heavy capital investments that make the field selling price of the gas relatively less important in its effect upon the final selling price. This photo showing cooling tower and gas scrubbers is typical of those seen throughout the natural gas country.

Natural Gas Enters Petroleum's Prime Markets

E. HOLLEY POE
E. Holley Poe and Associates, New York

***THE EFFECT OF** natural-gas extensions on sale of kerosine, light heating oil and residual fuel oil is something that is of particular concern to those segments of the oil industry that refine and market such products. Mr. Poe was asked by Division of Marketing, American Petroleum Institute, to discuss the matter before a group session during the recent Chicago meeting at which time he gave the accompanying realistic picture of present conditions and future prospects. "The entire history of the petroleum industry has been one of adjustment to change," he declared. "No doubt these changes are already being made."*

IT IS the purpose of this discussion to give the *realistic*—not *pessimistic*—appraisal of the situation which has caused all oil men to be greatly concerned about the rapid growth of natural-gas distribution . . . and how it will affect the oil industry's sales of kerosine, light heating oil and residual fuel oil.

All of us fall into the habit of applying inferences of our own to words which go far beyond the dictionary definition. When someone comes in to see us and says "Now I am going to be entirely realistic," we usually brace ourselves and get ready for bad news.

A study of the whole broad problem of the impact of natural gas on the sale of certain of the oil industry's products, brings about two conclusions: One is something that you already know; i.e., that, so far as the marketing division of the oil industry is concerned, this is no bad dream which will just pass over, come tomorrow's dawn. It is real competition; it will grow instead of diminish; and it will certainly have a profound effect on your business, not only on your marketing, but clear back to your refinery practices.

The other conclusion—and a more cheering one as far as the oil industry is concerned—is that this is *not* a picture of unrelieved distress and gloom, with no foreseeable end in sight except the gradual extinction of your business.

The natural growth of our living economy has so far assured all of us of adequate markets when we were able to deliver wanted goods and services. The market categories of the segments of this economy will continue to change as they have changed. The production of kerosine was once the only reason for the existence of the refining industry. Gasoline was merely a too highly volatile fraction which had to be disposed of on a distress-production basis. Liquefied petroleum gas was once something which we had to weather off out of casinghead gasoline which stood in open tanks until it was tamed down to the place where it could be safely used as a motor fuel, in cool weather.

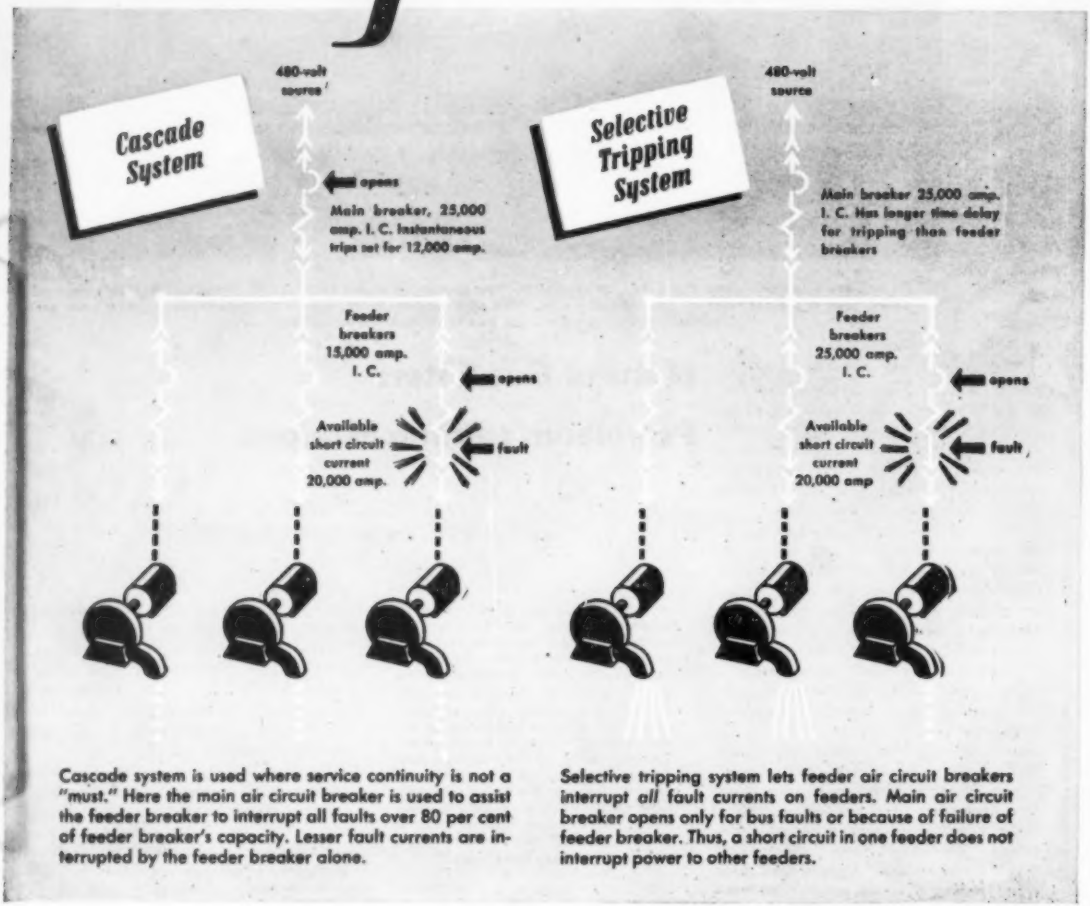
Changing conditions bring about new demands for products. To the extent that natural gas brings about a proportionate decrease in demand for some of your lighter oils, the readjustment of refinery and production procedures will become a matter for top management of the petroleum industry to recognize and prepare for. It can't be done—and it won't be done—by the marketing branch's of the industry worrying itself into a mass case of stomach ulcers.

The use of natural gas in the fuel markets of the country is no longer a matter of mathematical calculation and engineering speculation. It is an accomplished fact, brought about by a combination of convenience value to the user and of economics to the gas transporter and supplier.

One is well aware of the extent of, and reason for, its impact on those fuel markets where that impact has already been felt. The appeal of stability of service, as well as flexibility and efficiency in its utilization—often at less cost to the consumer—has proved that the acceptance of natural gas in any area, once it has been introduced, is not even open to question.

From the standpoint of the industry, natural gas is essentially a single one-way operation from well head to burner tip. It is a profitable operation for the gas

What's the trend in refinery electrification? ... better


Cascade System
480-volt source
opens
Main breaker, 25,000 amp. I. C. Instantaneous trips set for 12,000 amp.
Feeder breakers 15,000 amp. I. C.
opens
Available short circuit current 20,000 amp.
fault
Selective Tripping System
480-volt source
Main breaker 25,000 amp. I. C. Has longer time delay for tripping than feeder breakers
Feeder breakers 25,000 amp. I. C.
opens
Available short circuit current 20,000 amp
fault

Cascade system is used where service continuity is not a "must." Here the main air circuit breaker is used to assist the feeder breaker to interrupt all faults over 80 per cent of feeder breaker's capacity. Lesser fault currents are interrupted by the feeder breaker alone.

Selective tripping system lets feeder air circuit breakers interrupt *all* fault currents on feeders. Main air circuit breaker opens only for bus faults or because of failure of feeder breaker. Thus, a short circuit in one feeder does not interrupt power to other feeders.

Here's what you need to modernize your power system!

WHEN YOU COME TO GENERAL ELECTRIC you get far more than the finest in electrical equipment. A General Electric application engineer, familiar with refinery practices, is at your disposal. If desired, he stands ready to take over the job of co-ordinating all the needed components, engineering your power distribution into one modern, efficient system.

protection against shutdowns

WITH SELECTIVE TRIPPING

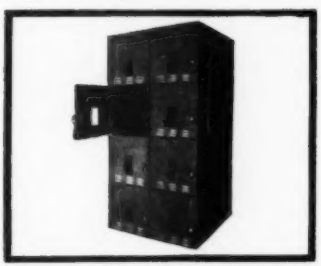
—to isolate faults on low-voltage circuits

Although comparatively new, selective tripping of air circuit breakers is becoming increasingly important in the field of low-voltage power distribution. Especially is this the case in applications—such as continuous processing in refineries—that require a high degree of service continuity. By isolating faults at remote points without tripping the main supply breaker, this method eliminates the costly production delays caused by complete power shutdowns.

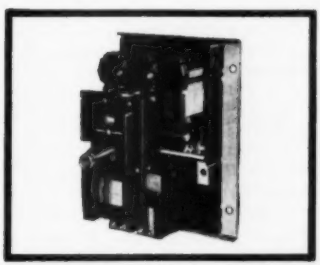
With selective tripping, full interrupting-rating breakers are used throughout, with differently-timed tripping ranges arranged so that the breaker farthest from the power source trips first. Thus, only that portion of the circuit nearest the fault is isolated. The rest of the power system stays in operation, permits uninterrupted production elsewhere in the plant.

For complete information on this new and cost-saving way of protecting your important low-voltage circuits, write for Bulletin GET-1485 "Selective Operation with Air Circuit Breakers." ***Apparatus Dept., General Electric Company, Schenectady 5, N. Y.***

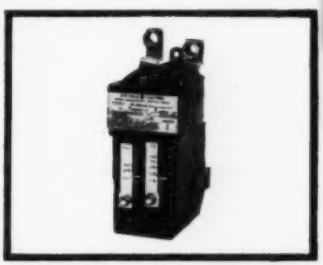
FREE G-E AIDS TO POWER SYSTEM SAVINGS! Here are ideas you can use on how to cut the cost of power distribution—your plant's most critical "materials handling" problem. Offered by General Electric as a service to your industry, they're contained in a full-color sound slidefilm, a factual manual, and a supplementary review booklet. All this is available to you and your organization without charge. Just ask your G-E representative to arrange for a showing of the film "Modern Industrial Power Distribution."



G-E metal-enclosed switchgear, containing air circuit breakers with new trip device, needs less floor space. Features include new rack-out mechanism, improved bus construction.



In the G-E Type AK-1 air circuit breaker (shown here with one trip device removed) you get improved arc interruption, multiple arcing contacts, and interchangeable trip units.



New G-E Type EC-1 tripping device for AK-1 air circuit breakers is sealed to eliminate maintenance, easily adjusted, readily removable for changing trip characteristics.

GENERAL ELECTRIC

661-4

producer, for the transporter, and for the distributing gas utility.

Detractors of the natural-gas industry were once wont to say that its profit possibilities lay largely in the fact that field prices were so low as to put the gas into the gathering lines at practically no cost at all. That was when gas was being sold in Texas for 3, 4, and 5 cents per 1000 cubic feet. But now that the going price has been doubled—and may very well go still higher—the growth of natural gas has accelerated rather than diminished, either because of it or in spite of it.

Miracles Won't Do!

Speaking of the price paid for gas, the hope has sometimes been entertained by a few in the oil industry that regulation may one day step in and perform some magic feat of pricing natural gas out of the competitive range in the consumer market by a mandatory floor under field prices. All of us are prone to wish at times that our competitive problems could be solved by legislation. The old NRA at the beginning of the Roosevelt depression was a gigantic laboratory demonstration of the fallacy of that theory. And it is my opinion that, in the long run, any new regulation imposed on field prices of natural gas must, and will, be accompanied by further regulation of the oil industry. Calling in the politicians to replace free enterprise strikes me as a last desperate measure which any business as fundamentally sound as oil should avoid like the plague.

Natural gas has been a competitor of oil and coal for many years, in most of the United States. All of the fuels have found adequate markets which they could supply at a profit. It is true, however, that John L. Lewis seems almost to have succeeded in pricing coal out of the best markets.

In order to get some perspective of the relative position of the great fuel and energy industries of the country, see Table 1:

Over the past 10 years there has been a phenomenal increase in all energy requirements of the country. The percentages of this increase enjoyed by various categories are unequal, but even coal has showed a gain in spite of its labor troubles, and in spite of the fact that it is the most vulnerable fuel for replacement by either oil or gas when prices are in any way comparable on a delivered Btu. basis.

This period has also witnessed the greatest expansion of natural-gas pipe lines since the industry became truly national in character in the late 1920's. The next question which naturally arises in your minds is whether the 97-percent increase in natural-gas utilization has been at the expense of the petroleum industry and, if it has, how badly have you been hurt.

The answer to that question is found in Table 2.

Again, as Table 2 indicates, both oil and natural gas not only have increased their energy output, but they also have increased their proportion of the whole. In fact, when you add 35.1 percent and 14.3 percent, you get a total of 49.4 percent, or practically half of the total energy requirements of the nation is being supplied by these two companion industries.

The gains, of course, were made at the expense of both anthracite and bituminous coal. Many of you are well aware of the vigorous and extremely well conducted campaign of obstruction which the coal industry—making common cause with the railroads and certain labor unions—waged against all natural-gas extension.

TABLE 1
United States Energy Requirements, in Trillions of Btu.'s

	1939	1948	Percent Increase
Anthracite coal	1,400	1,552	11
Bituminous coal	10,345	15,563	50
Petroleum	7,789	12,874	66
Natural gas	2,663	5,235	97
Water power	838	1,479	77
Total	23,035	36,703	60

TABLE 2
Distribution of Energy Supply in the United States

	1939 (Percent)	1948 (Percent)
Anthracite coal	6.1	4.2
Bituminous coal	44.9	42.4
Petroleum	33.8	35.1
Natural gas	11.6	14.3
Water power	3.6	4.0
	100.0	100.0

Of course, it is obvious that natural-gas transmission is one of America's fastest growing industries. It has thrived and grown during this postwar period in spite of the high construction costs which have almost stalemated many another industry's expansion. Pipe-line operators at one time used a sort of rule-of-thumb estimate that it cost a penny per thousand cubic feet per hundred miles to move gas from the source to the market. That cost has advanced now until it is roughly 1½ cents; yet the expansion still goes on.

Almost daily another few miles are added to the natural-gas lines which cover the country like a gigantic spider web. It is hard to believe, but it is a fact, that at the end of 1948 there were 251,330 miles of natural-gas transmission lines in the United States. That's about 26,000 more miles than there are point-to-point railroad lines; and it exceeds the total oil pipe lines by more than 100,000 miles. A major portion of the gas industry's $3½-billion expansion program has been earmarked for transmission lines.

The Federal Power Commission recently announced that natural-gas pipeline authorizations during the 12 months ending June 30, 1949, totaled 7045 miles of line. This will increase the daily gas-transmission capacity by 2600 million cubic feet. This construction, when completed, will cost about $600 million, and will have a daily Btu. throughput equal to 446,000 barrels of oil. To look at it another way, the lines authorized just during this one year can transport annually energy equal to 163 million barrels of oil. This is equivalent to 50 percent of all the distillate fuel oil sold in 1948.

Where Does It Go?

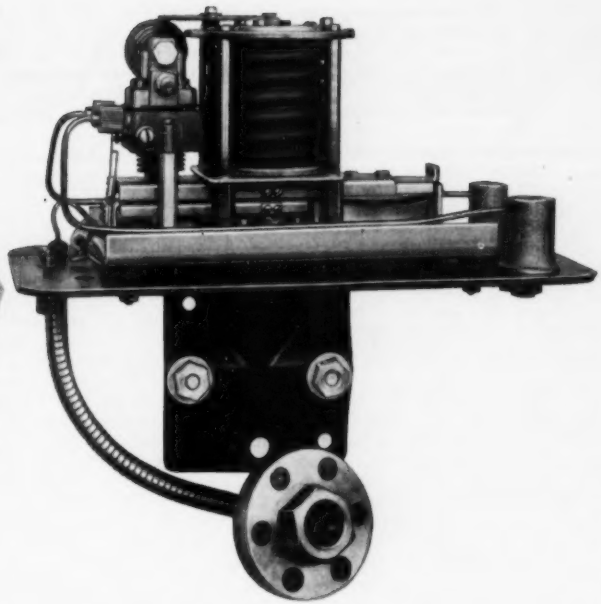
This tremendous volume of gas is going all over the country—to the Middle West, the Pacific Coast, the deep South and, most important so far as your interests are concerned, into the densely populated and highly industrialized Atlantic seaboard states. There, for the most part, it will be sold to existing gas-distributing companies for resale to millions of domestic, commercial, and industrial customers. This is to be the greatest invasion of any fuel market that has ever been conducted at one time in all history. A recent study conducted by the *American Gas Journal* shows that the gas companies within reasonable distance of the pending and proposed pipe lines have a total of more than 6.8 million customers, most of whom are at present receiving low Btu. manufactured gas.

Although natural gas production has been doubling every 10 years, new reserve discoveries have been increasing even faster. For example, the net production in 1920 was about 800 billion cubic feet, and the estimated recoverable reserves stood at 15 trillion. In 1948 our net production was in excess of 6 trillion cubic feet, and the reserves had been "depleted" from 15 trillion to 174 trillion cubic feet.

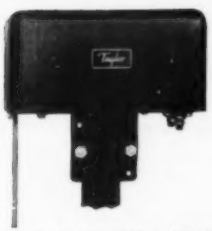
Natural gas will soon be available in quantity in New Jersey, eastern Pennsylvania, New York, and most of New England. Much of this territory has long been considered the top oil market of the nation. Here the local gas utilities, each depending on its own situation so far as the manner and extent of usage are concerned, will use natural gas as a substitute for gas oil in reforming and enriching, or they will convert their customer's appliances and go to the distribution of straight natural gas.

Even though the fuel requirements of these eastern areas are growing by leaps

Now you can measure and transmit smallest pressure changes with TAYLOR ACCURACY!



New Taylor TRANSAIRE* Pressure Transmitter with NARROW RANGE SPANS



FIRST TIME in history! A simple force-balance pressure instrument that measures and transmits the smallest pressure changes up to 1000 ft. with an accuracy of ½% of the range span (*conventional devices are only accurate up to ½% of upper range limit.*)

Taylor's new TRANSAIRE Pressure Transmitter gives you accuracy and sensitivity never before possible in pressure measurement—plus the convenience of suppressed ranges at high pressure levels.

SEVEN IMPORTANT ADVANTAGES:

1. RANGE SPANS OF 20 AND 40 PSI available throughout range limits of 35 to 415 psia. With accuracy established at ½% range span, you can expect precise measurement to .1 psi with 20 psi spans, and .2 psi with 40 psi spans—and consequently proportionately closer control.

2. VOLUMETRIC TYPE PRESSURE SYSTEM is extremely accurate. Being a completely closed system there is practically no hazard of clogging. Type 316 stainless steel diaphragm and connection give maximum corrosion resistance.

3. PERFECT FOR MANY JOBS, especially on thin fractionating columns in chemical and petroleum industries, etc.

4. STANDARDIZED 3 TO 15 PSI OUTPUT Air Pressure means you don't have to individually calibrate receivers or receiver-controllers. Instrument transmits output pressure in proportion to measured pressure with accuracy of ±0.06 psi.

5. OPERATING RANGE VARIED by simple screwdriver adjustment.

6. INTERCHANGEABLE MANIFOLD ASSEMBLIES make 20 and 40 psi range spans optional.

7. INSTRUMENT QUICKLY TRANSFERRED from one job to another having different range by simply inter-changing spring sub-assemblies.

This Taylor TRANSAIRE Pressure Transmitter is another step in Taylor's program to produce industrial instrumentation unsurpassed in *accuracy*, *simplicity*, and *durability*. We're doing this, of course, to help you keep costs down and quality up. Ask your Taylor Field Engineer! Or write for **BULLETIN 98099.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.

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TAYLOR INSTRUMENTS MEAN ACCURACY FIRST

and bounds, it only stands to reason that the annual absorption of hundreds of trillions of Btu.'s in the form of natural gas cannot be accomplished without some fuels suffering losses. One indication is this fact: In natural-gas areas the annual average domestic and commercial consumption per customer is 75,000 cubic feet of thousand-Btu. gas. The average consumption in New England and metropolitan New York has been only 25,000 cubic feet of manufactured gas which contains only half the heating value of natural gas. Reducing this to its natural-gas equivalent, it would indicate that that area is now consuming in Btu.'s considerably less than one-fifth of the national average.

An Interesting Shift

How much increased consumption will be enjoyed under natural gas—and how soon—nobody knows, although the companies are diligently researching the matter. Historically, it is known that coal—which has the least desirable utilization features and which now has almost the highest price—is likely to suffer most. Nor can the exact amount of the losses which will be borne by existing fuels be accurately determined in advance.

The central Atlantic and New England states comprise the cream of your kerosine and range-oil market. In 1947, for example, more than 60 percent of the entire sales for the country was concentrated in this small section. In most instances this range oil is delivered by a small fuel-oil dealer from his combination oil and ice truck. In this respect, the marketing of Btu.'s for household use hasn't advanced over the horse-and-buggy days; literally hundreds of thousands of housewives daily or weekly purchase range oil for cooking, for water heating, and for space heating. Prior to the early 1930's coal and coke dominated this market; but the convenience and efficiency of oil-burning equipment, and the aggressive and intelligent promotion by you gentlemen, have about eliminated solid fuels for these uses in that area.

The great majority of these dwellings have gas connections already, and many more are within easy reach of distribution lines; so it is obvious that lower-priced gas, whether mixed or straight natural, will be a serious competitor.

The change will not come overnight; but, if the rapid shift from coal to range oil is any criterion, it will behoove the oil industry to prepare for a very pronounced decline in its kerosine market.

Another oil market which may be threatened by natural gas is that of home and commercial heating. Like kerosine, heating oils find their best market in New Jersey, New York, and New England—more than 45 percent of all the oil-burner installations are in these eight states. And better than 55 percent of all the centrally heated dwellings in New England are heated by oil!

According to a recent study published by the University of Illinois, 8-cent-per-therm gas is equal to No. 2 fuel oil at 11.2 cents per gallon, or to anthracite coal or coke at $20 per ton. The study takes into consideration burner efficiencies, so that the costs to the user are comparable, and 8-cent-per-therm gas would be considered a reasonable natural-gas heating price. Both oil and solid fuels are selling at prices higher than that in most of these sections today.

Looking at it nationally, about 6.6 million of the 20 million gas-using homes in the United States are already heated by gas, and an additional 693,000 new space-heating customers are expected by this coming winter. Needless to say, the great majority—something like 6,450,000—of the gas-heated homes are on natural-gas lines. In the main, manufactured gas has not competed successfully with oil.

In California, gas enjoys about a 96-percent saturation of heating; in Ohio, almost 50 percent; and in states like Kansas and Oklahoma, it is practically 100 percent. However, you don't have to worry about such saturations in the East. In the first place, under present conditions, it would be economically impracticable to build the gas lines which would handle the load if all homes now using oil were to convert to natural gas. For instance, to do this in New England alone would require two lines, *each* capable of carrying the *combined* capacity of both of our Texas Eastern Transmission Corporation lines. If New Jersey and New York were included, it would take five pipe lines of similar carrying capacity. Without going into the technical details of load-balancing problems, you can rest assured that the billion-dollar investment which would be required to handle such an unbalanced load would not be economically feasible.

Then, too, so long as we are allowing the sunshine of hope to gleam through our observations, there are thousands of homes which have relatively sizable investments in oil-heating equipment. So long as the price of heating oil remains within a reasonable range, compared to gas, it is not likely that these householders will rush to throw out their oil burners, even for a slight operating or convenience advantage.

Residual Oil

The last market in which oil can expect competition from natural gas is in the residual-oil market. This is the market in which oil has been replacing coal steadily and irresistibly over the years. A New York financial paper stated recently that "coal produced only 44 percent of the output of electric utilities during July— the lowest figure on record." True, natural gas contributed somewhat to this new low of the coal industry, but it is hardly a drop in the bucket compared with the coal replaced by low-priced heavy oil. Some utilities in the East are planning to use, and will use, a certain amount of natural gas as boiler fuel, but it is not believed that the total will ever be very sizable.

Natural gas is too superior a fuel to be used extensively in this manner in the eastern areas, where both oil and coal are plentiful. Primarily, its use for this purpose will only be where load balancing requires it. The Federal Power Commission, without any authority actually to regulate end uses of gas, has adopted the attitude that its use for boiler fuel should be discouraged, and new certificates issued quite generally contain service provisions which keep it to a minimum.

Not to be overlooked on the plus side of the oil-industry outlook are the almost spectacular developments which have been made in recent years in the manufacture of high-Btu. oil gas. The initial cost of the equipment to manufacture such gas is low, compared to other methods, and there are many advantages to both the gas utilities and their customers. So far as the gas companies are concerned, the wide range of interchangeability between high-Btu. oil and natural gas makes the former most attractive as standby and peak shaving equipment. There are about 70 of these installations in the United States, and the list is growing every day.

It is perfectly conceivable that, under certain conditions, high-Btu. oil gas can be made and sold in many sections of the country at a cost less than that of natural gas delivered at the city gate.

Fuel Revolution

All of the foregoing indicates at least one thing: that we are in the midst of a fuel revolution. But there are factors which are aside from and above the cold statistics of any industry's prospects. They are such intangibles as intelligent research, adaptation to change, and plain old-fashioned salesmanship.

To the alert and the aggressive, change is never devastating—even though it may be momentarily disturbing. The oil industry has long since gained the reputation of being a fast and shifty fighter in any ring. Its whole history has been one of anticipation of, and adjustment to, new conditions. Whether those adjustments had to start in the field, at the refinery, or in the marketing of the product, they have always been made. And the author is thoroughly confident that they will be made now!

80% Heating Efficiency*

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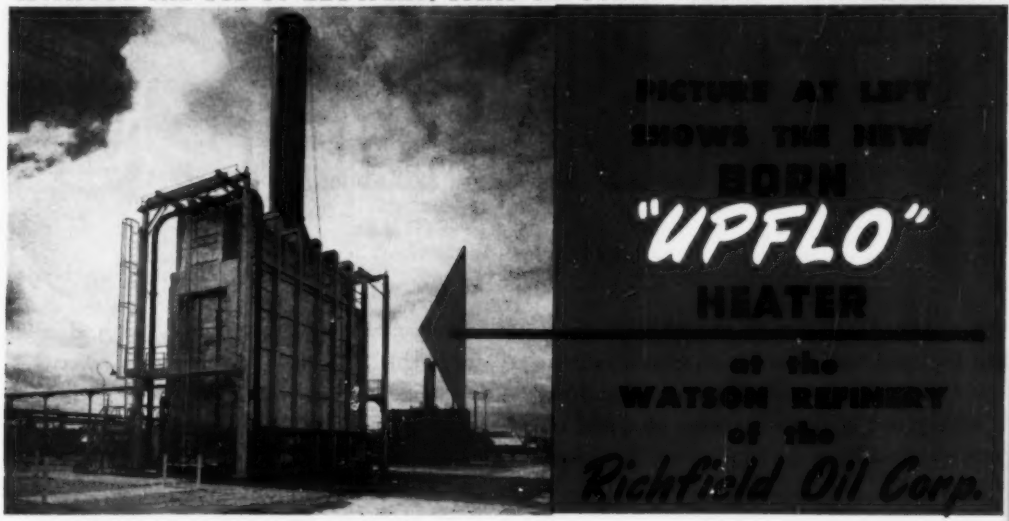

Operating Data

Stack Temperatures	640° F.
Furnace Temperature	1360° F.
Oil Temperatures	
Heater Inlet	339° F.
Radiant Outlet	601° F.
Oil Flow	828 Bbls/hour
Draft	
Stack	0.23"
Orsat	
CO_2	13.0%
O_2	3.0%
Excess air	16.0%
*Efficiency (H.H.V.)	79.8%
Efficiency (L.H.V.)	86.3%

Unbelievable . . . not when it's a Born "Upflo" Heater. Incredible . . . not at all. Just look at the operating data shown on the left.

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The addition of chromium in excess of 11% to steel provides, according to most generally accepted theory, a thin, adhering self-healing oxide film that protects the underlying metal. The result is a series of alloys highly resistant to corrosion and tarnishing in a wide variety of corrosive media.

Six per cent or more of nickel when added to chromium stainless steels produces a series of alloys of improved corrosion resistance known as the austenitic chromium-nickel stainless steels. Recognition by industry of this improvement is indicated by the fact that approximately two-thirds of all stainless steel tonnage produced is of the chromium-nickel type.

In the annealed condition austenitic chromium-nickel stainless steels are strong, tough, ductile and pliable. When cold-worked they are effectively strengthened and hardened; a tensile strength in excess of 200,000 p.s.i. is easily developed. Annealed, and even in the cold-worked condition, they are adaptable to many forming operations. In all conditions they are readily weldable.

At elevated temperatures, austenitic chromium-nickel stainless steels are distinguished by their strength and outstanding resistance to oxidation. At temperatures down to −300° F. they retain their toughness and unusual strength.

Other elements are sometimes added to give specific properties: to improve machinability, enhance scaling resistance, improve resistance to corrosion in specific, difficult cases.

Leading steel companies produce austenitic chromium-nickel stainless steels in all commercial forms. A list of sources of supply will be furnished on request.

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THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

REFINERY and Other PLANT CONSTRUCTION

Petroleum Refiner's construction boxscore (see next page following construction notes, below) is an exclusive feature, which offers in easy-to-read fashion the up-to-date building picture.

McMurray to Build Tyler Cat Cracker

A 5000-barrel-per-day system is to be constructed by Universal Oil Products Company at McMurray Refining Company's Tyler, Texas refinery. Included in the plans are a fluid cat cracker, gas concentration unit and feed preparation and cycle oil cracking unit. Its completion, scheduled for next fall, will climax the refining company's expansion and modernization program started 18 months ago.

The gas concentration system will extract propane and butane and at the same time prepare stock for the polymerization unit recently placed in operation at the plant. The feed preparation system is designed to give maximum flexibility in products selection. Crude for the plant is drawn from the East Texas field. Last year it processed over 2 million barrels.

Evangeline Completes Portable Perco Unit

A 400-barrel-per-day $38,000 portable Perco Cycloversion unit to reform distillate and engineered and designed by Grebe & Doremus Process Company, has been installed in the Jennings, La., refinery of Evangeline Oil Refining Company. Fabricated in Houston by Mason Brothers, the unit was delivered to the plant ready for operation except for setting the fractionating tower and connecting the process and utility lines.

IROM's ITALIAN Refinery Plans Recovery Project

Present production of an Italian refinery located at Porto Marghera, near Venice, will be increased from 3.9 million barrels per year to 8.2 million barrels annually under an industrial recovery project, the Economic Administration announced in Washington and Rome. The project calls for the installation of a combined atmospheric and vacuum distillation unit, and acid treating and contact filtration unit for lube oils, and electric generating unit and facilities for truck and tank car loading.

Estimated cost of expanding and modernizing the facilities of IROM (Societe Raffinzione Olli Minerali) is the equivalent of $6.4 million including $2 million in ECA assistance funds. The remainder of the costs will be provided by the company in Italian currency. ECA's funds will be used for the purchase of special equipment in the United States and for engineering fees.

The refinery uses Middle East crude and serves the industrial area in the Po Valley, Venice and other Adriatic ports. It was severely damaged during the war, but has since been rehabilitated and is now operating at capacity.

Trinidad Leaseholds Sets New Gaso Goal

Trinidad Leaseholds, Ltd., hopes by 1952 to have its Trinidad refinery modernized to the point where the company will have ample cracking capacity and be able to make gasoline to meet any likely specification required by any world market, according to a statement made last month by Board Chairman Simon J. Vos, the most important part of the $16 million refinery modernization program, which the company has asked the British government to approve, is the installation of a fluid catalyst cracking plant with a capacity of 15,000 barrels per day, with attendant vacuum distillation column for feed preparation.

Capacity of the refinery, in excess of 65,750 barrels per day, cannot be utilized economically, according to Vos, as the capacity of the cracking plant does not match this thruput. The company has negotiated a long-term contract with its most important supplier of Trinidad crude, Apex (Trinidad) Oilfields, Ltd., and the Trinidad government has granted Vos's company an exemption from duty for oil imported for 25 years.

Shell Development Expands Emeryville Laboratories

Plans to erect a new four-story building at its Emeryville, Calif., laboratories have been announced by Shell Development Company. The new space is needed to carry on the company's research plans which currently call for an expenditure, worldwide, of about $24 million yearly.

The new building, which is part of a larger construction already under way, will allow for a shifting and reallocation of space within the plant and will provide additional space for both laboratory facilities and staff.

Brown & Root Awarded United Gas Contracts

Contracts totaling $1 million have been awarded by United Gas Pipe Line Company to Brown & Root, Inc., Houston, for the construction of gathering lines, a transmission line and a gas dehydration plant designed to withdraw 30,000 mcf. gas daily from 13 fields in DeWitt and Goliad counties southeast of San Antonio.

Contracts provide for 34 miles of gathering lines and a 12-mile 16-inch transmission line to be connected to the main lines running to Austin and San Antonio.

ECA Approves Funds for Scottish Petrochem Plant

A petroleum chemical plant at Grangemouth, Scotland, for the production of ethyl and isopropyl alcohol has been approved by Economic Co-operation Administration. The project for British Petroleum Chemicals, Ltd., provides for alcohol plants as first part of a three-stage construction program.

Anglo-Iranian Oil Company, Ltd., one of the plant's joint owners, will supply raw materials to the new plant which will be located adjacent to its Grangemouth refinery. Total cost for the first stage of the program is the equivalent of $17 million, including $6.5 million in ECA funds to cover engineering fees and services and purchase of special equipment in the U. S. Remainder of construction costs will be furnished by plant's other joint owner, Distillers Company, Ltd.

New Owners of Atlas Plan More Facilities

The 12,000-barrels-per-day refining facilities of Atlas Oil & Refining Corporation, located at Shreveport, La., and its pipe line facilities from Magnolia field, Ark., to Minden, La., will be sold to Chicago Corporation about January 1, according to an agreement between the two companies. In acquiring the facilities, Chicago Corporation will be acting on behalf of a group of companies which will take over the operating functions under a new name. No change in the management is contemplated.

Additional facilities will be constructed by the group, and refinery operations will be expanded to include the processing of distillate stocks from one or more gas plant operations in which the participating members of the group have interests.

Sohio to Expand Cleveland Cat Cracking Facilities

Plans for a $4.5 million expansion of the catalytic cracking facilities at Standard Oil Company's (Ohio) Cleveland refinery No. 1 will provide capacity within the range of 18,000 to 22,000 barrels of feed stock per day. It is anticipated that the facilities will be in operation in about 15 months.

This expansion is part of Sohio's $100 million three-year program. The present cat cracking unit at the refinery was built in 1944 to produce wartime aviation gasoline and has a capacity of approximately 12,000 barrels of feed stock per day.

Construction plans being prepared by the company's engineering department

are based on conversion of the Houdry fixed-bed unit to a moving-bed unit to a moving-bed type. This will be accomplished by replacement of the fixed cases with a moving-bed reactor-regenerator system. The company has not however decided what process will be employed.

Work Progressing on New Condor Italian Refinery

Work on the site of the new 7.5 million barrels per annum refinery of Condor S. p. A. per l'Industrial Petrolifera e Chemica at Rho, near Milan, Italy, is progressing satisfactorily, according to a Manchester Oil Refinery, Ltd., announcement. At the same time, planning and development work has started on the 100-mile, 10-inch pipe line which will carry crude oil from Genoa to the refinery.

Condor, which is "completely independent of the major oil companies or of any crude oil producer," will purchase for the Italian economy crude oil from whatever source is advantageous from the aspect of quality, price and availability of foreign currency.

Manchester Oil Refinery, Ltd., will participate in Condor, enabling the latter to keep in close contact with developments in refining technique and in close touch with market for crude oil and tankers, it was said. Also predicted to be closely associated with Condor are Petrocarbon Ltd. and Petrochemicals Ltd.

The geographical position of the Condor refinery in Rho, will lend itself well to the development of chemicals from petroleum, as the main chemical industries of Italy are in that region and the intermediate products could be easily and cheaply transported to the existing chemical factories in that area, the announcement said.

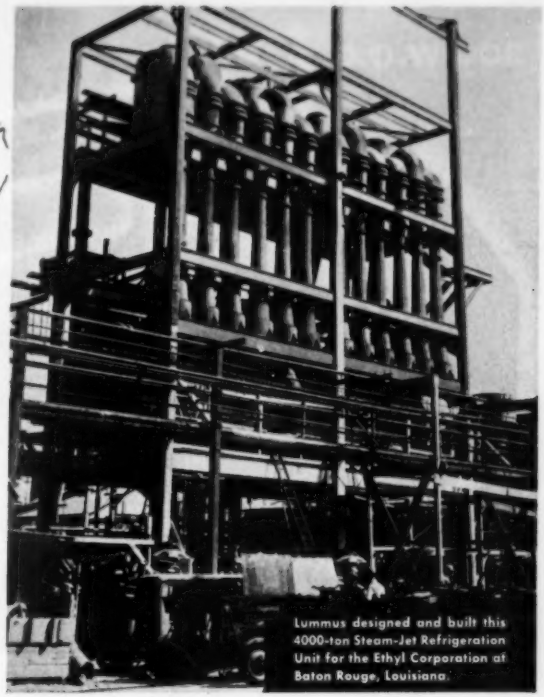
TABULATION OF REFINERY AND OTHER PLANT CONSTRUCTION

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EAST									
*California Refg. Co	Perth Amboy, N.J.	Houdriflow Cat. Crk.	25,000		Engineering	.....	Houdry	Houdry, Braun	Braun
E. I. DuPont	Parkersburg, W. Va.	Tetrafluoroethylene Resin Plant	.....	.....	Under Constr.	Summer, 1950	.....	.....	.....
Esso Standard Oil	Bayonne, N.J.	MEK Dewaxing	7,500 bbls.	.....	Under Constr.	Jan., 1950	Texaco	Badger	Badger
Esso Standard Oil	Bayonne, N.J.	Steam Boilers	400,000 lbs. hr.	.....	Under Constr.	2nd Qtr., 1950	.....	S.O.D., Day & Zimmermann	S.O.D. & Zimmermann
*Freedom-Valvolene Oil Co.	Freedom, Pa.	Filter Plant	800 bbls.	.....	Under Constr.	Late, 1949	.....	.....	.....
Freeport Sulphur Co	Westville, N.J.	Sulfur Recovery	40 tons	.....	Contracted	.....	.....	.....	Girdler
The Pure Oil Co.	Savannah, Ga.	Lube Bld, Pkg.	.....	.....	Under Constr.	Nov., 1949	.....	.....	.....
Quaker State Oil Refining Corp.	Emlenton, Pa.	Boiler Plant Add.	65,000 lbs. hr.	$160,000	Under Constr.	Jan., 1950	.....	.....	Staff
Socony-Vacuum Oil Co., Inc.	Paulsboro, N.J.	Crude, Dist. Unit	19,500 bbls.	.....	Completed	.....	.....	Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	Propane Deasph.	5,950 bbls.	.....	Under Constr.	Dec., 1949	Juik	Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	MEK Dewaxing	2,050 bbls.	.....	Under Constr.	4th Qtr., 1949	Texaco	Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	Light Oil Trtng.	28,000 bbls.	.....	Designing	Dec., 1949	.....	Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	Mod. Comp. Pkg. Dept.	5,000 bbls.	.....	Under Constr.	Jan., 1950	.....	Staff	Staff
L. Sonneborn Sons	Petrolia, Pa.	Antipollution	.....	$400,000	Under Constr.	1st Qtr., 1950	.....	Chemico	Knowles
Sun Oil Co.	Marcus Hook, Pa.	Compnd., Pkg.	.....	.....	Completed	.....	.....	Staff, Lindsay	W. W. Lindsay
The Texas Co.	Beacon, N.Y.	Expand Research Labs.	.....	.....	Under Constr.	Dec., 1949	.....	Voorhees, Walker, Foley & Smith	.....
The Texas Co.	Westville, N.J.	New Refinery	40,000 bbls.	.....	Under Constr.	Dec. 15, 1949	.....	Foster Wheeler, Jackson-Moreland, Kellogg	Foster Wheeler, Kellogg
United Refining Co.	Warren, Pa.	Lab. Steam Gen.	60,000 lbs. hr.	.....	.....	4th Qtr., 1950	.....	.....	Union Iron Wks.
U.S. Dept of Interior	Bruceton, Pa.	Fischer-Tropsch Pilot Plant	1-2 bbls.	$150,000	Completed	.....	.....	Staff	Blaw-Knox Co.
MID-CONTINENT									
Ashland Oil & Refining	Canton, Ohio	Ref. Modern.	.....	.....	.....	.....	.....	.....	Cat. Constr.
*Byerlite Corp.	Heath, Ohio	Two Oxidizers	2,000 bbls.	$18,000	Completed	.....	.....	.....	.....
Champlin Refining Co.	Enid, Okla.	Crude Unit	18,000 bbls.	$600,000	Under Constr.	Nov., 1949	.....	Koch	Staff
Champlin Refining	Enid, Okla.	Cat Poly Unit	450 bbls.	$200,000	Under Constr.	Nov., 1949	U.O.P.	Koch	Staff
Cities Service, Del.	Cicero, Ill.	Compound Flr.	1,200 bbls	$4 million	Contracted	July, 1950	.....	.....	Sollitt
Cooperative Ref. Assn.	Coffeyville, Kan.	Dewaxing	2,200 bbls.	$1.5 million	Completed	.....	Texaco	Process Eng.	Process Eng.
*Columbian Fuel Corp.	Hickok, Kans.	Desulfurization	2,000 mcf	$15,000	Under Constr.	Dec., 1949	.....	Graff	Graff
Continental Oil Co.	Ponca City, Okla.	Crude Dist. Unit	52,000 bbls.	.....	Completed	.....	.....	Bechtel	Bechtel
*Consolidated Gas Utilities Corp.	Cement, Okla.	Comp. Sta.	40,000 mcf	.....	Under Constr.	Jan. 1, 1950	.....	Dresser	Dresser
Deep Rock Oil Corp.	Cushing, Okla.	Cat. Cracker	5,000 bbls.	.....	Under Constr.	Spring, 1950	.....	U.O.P.	J. & L. Constr.
The Derby Oil Co.	Wichita, Kans.	Cat. Crk Change	.....	.....	Planning	.....	.....	.....	.....
Dewese Oil Co.	Weston, Ohio	Lube Filtering	250 bbls.	$15,000	Under Constr.	Spring, 1950	.....	Staff	Staff
*The Dow Chem. Co.	Midland, Mich.	Comp. Sta. & Pipeline	5,000 mcf gas	$1.5 million	Under Constr.	Jan., 1950	.....	Staff	Prichard, Mahoney
Ethyl Corp.	Ferndale, Mich.	Batch Gasoline Distil. Units	1 to 3 bbls.	.....	Contracted	4th Qtr., 1949	.....	Rust Pro.	Rust Pro.
Globe Oil & Ref. Co.	Lemont, Ill.	Cat. Cracker	6,000 bbls.	$1 million	Buying Material	Jan. 1, 1950	U.O.P.	U.O.P.	.....
Gulf Oil Corp.	Kiefer, Okla.	Gaso. Plant	14,500 mcf	.....	Under Constr.	.....	.....	.....	.....
Gulf Refg. Co.	Cincinnati, Ohio	Fluid Cat. Crk	15,500 bbls.	.....	Completed	.....	.....	Kellogg	Kellogg
Hoosier Gas Corp.	Vincennes, Ind.	Desulfo Unit	3,000 mcf	.....	Completed	.....	.....	Stacey, Dresser	Staff
Indiana Farm Bureau Cooperative Assn.	Mt. Vernon, Ind.	Fluid Cat. Cracking Unit	4,000 bbls.	.....	Under Constr.	1951	.....	U.O.P.	Staff
Lever Bros. Co.	Hammond, Ind.	Hygirtol Plant	150,000 alf	.....	Under Constr.	Jan. 1, 1950	.....	Staff	Girdler
M. F. A. Oil Co.	Chanute, Kans.	Desulfurization	1,000 bbls.	$75,000	Completed	.....	Phillips	Koch	Koch
Magnolia Pet. Co.	Grant County, Kans. (Hickok)	Gasoline Plant	100,000 mcf	.....	Under Constr.	Jan., 1950	.....	Staff, Walco	Walco
Magnolia Pet.	Chitwood, Okla.	Pressure Maint. & Cycling	24,750 mcf	.....	Under Constr.	Dec., 1949	.....	Staff, Constr. Service	Constr. Service
Magnolia Pet.	Stephens County, Okla.	Gasoline Plant	30,000 mcf	.....	Under Constr.	Jan., 1950	.....	Staff, J. & L. Constr.	J. & L. Constr.
Midland Cooperative Wholesale	Cushing, Okla.	Cat. Poly Unit	200 bbls.	.....	Authorized	Early 1950	.....	.....	Ref. Eng. U.O.P
Mississippi River Fuel Co.	Star City, Ark.	Comp. Sta.	5,000 hp.	.....	Under Constr.	Feb., 1950	.....	Ref. Maint.	Ref. Maint.
*Mississippi River	Pocahontas, Ark.	Comp. Sta.	5,000 hp.	.....	Under Constr.	Feb., 1950	.....	Ref. Maint.	Ref. Maint.
*Mississippi River	Fredericktown, Ark.	Comp. Sta.	4,000 hp.	.....	Under Constr.	Feb., 1950	.....	Ref. Maint.	Ref. Maint.
*National Co-Op. Refinery Assn.	McPherson, Kans.	Polymerization	450 bbls.	$430,000	Planning	.....	U.O.P.	.....	.....
Northern Natural Gas Co.	Bushton, Kans.	Inc. Comp. Cap.	1,600 hp.	.....	Completed	.....	.....	.....	Dresser
Northern Nat. Gas	Clifton, Kans.	Compress. Add.	1,600 hp.	.....	Under Constr.	1949	.....	.....	Fluor
Northern Nat. Gas	Mullinville, Kans.	Inc. Comp. Cap.	3,200 hp.	.....	Under Constr.	Nov., 1949	.....	.....	Dresser
Northern Nat. Gas	Sublette, Kans.	Gasoline Plant	265,000 mcf	.....	Authorized	1950	.....	.....	Pritchard
Northern Nat. Gas	Sublette, Kans.	Increase Comp.	3,200 hp.	.....	Under Constr.	1949	.....	.....	Fluor
*Northwestern Refining Co.	St. Paul Park, Minn.	Loading Rack, Products Transfers Line	500,000 gals.	$40,000	Under Constr.	Jan., 1950	.....	Staff	Staff

■ CONTINUED ON PAGE 87

WORLD'S LARGEST

steam-jet refrigeration unit



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TABULATION OF REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Oklahoma Refg. Co.	Seminole, Okla.	Refinery	200 bbls.	$40,000	.....	4th Qtr., 1949	.....	.....	.....
Old Dutch Refg. Co.	Muskegon, Mich.	Platforming Unit	2,000 bbls.	.....	Completed	.....	U.O.P.	U.O.P.	Staff
*Osceola Refining Co. Inc.	Reed City, Mich.	Desalting Unit	2,000 bbls.	$10,000	Authorized	4th Qtr., 1949	Petreco	Petreco	Staff
Pan-Am. Southern Corp.	El Dorado, Ark.	Delayed Coke Water Cooling Tower, Steam Gen. Boiler, Coke & Loading	9,300 bbls.	.....	Planning	Sept., 1950	.....	Lummus	Lummus
Peteo Corp.	Blue Island, Ill.	Houdri, Cat. Crk., LPG Recov.	5,000 bbls.	$400,000	Under Constr.	4th Qtr., 1949	Houdry	Houdry	Clarke
*Petroleum Specialties, Inc.	Flat Rock, Mich.	Cat. Cracker	3,000 bbls	$2 million	Planning	.....	.....	.....	.....
Phillips Pet. Co.	Kansas City, Mo.	Cat. Crack	24,000 bbls.	$10 million	Under Constr.	Dec., 1949	.....	Braun	Brown
Phillips Pet., et al.	Edmond, Okla.	Absorp. Plt. Add.	60,000 mcf	.....	Authorized	Mar., 1950	.....	.....	Ref. Maint
The Pure Oil Co.	Toledo, Ohio	Revamp. Crd. Reform.	.....	.....	Under Constr.	1949	.....	.....	Cat. Constr
The Shallow Water Refining Co.	Shallow Water, Kansas	Reforming Unit	1,250 bbls.	$85,000	Under Constr.	April, 1950	Perco	Koch Eng.	Koch Eng
Skelly Oil Co.	El Dorado, Kans.	Crd. Dist. Cat. Crk.	†35,000 bbls.	$8-10 million	Under Constr.	Mid 1950	.....	.....	.....
Socony-Vacuum	E. St. Louis, Ill.	Crude Distil.	15,000 bbls.	.....	Completed	.....	.....	Staff	Bechtel
Socony-Vacuum	E. St. Louis, Ill.	Thermal Crack	13,200 bbls.	.....	Under Constr.	Jan., 1950	.....	Staff	Bechtel
Socony-Vacuum	E. St. Louis, Ill.	Misel. Ref. Addns.	.....	.....	Under Constr.	Jan., 1950	.....	Staff, Bechtel	Bechtel
Socony-Vacuum	E. St. Louis, Ill.	Delayed Coking	8,700 bbls.	.....	Under Constr.	March, 1950	.....	Staff, Bechtel	Bechtel
Socony-Vacuum	Augusta, Kans.	Houdry Conversion to T.C.C.	15,000 bbls.	.....	Planned	Mid., 1950	Socony-Vacuum	.....	.....
Socony-Vacuum	Trenton, Mich.	Houdry Conversion to T.C.C.	15,000 bbls.	.....	Planned	Mid., 1950	Socony-Vacuum	.....	.....
Standard Oil Co., (Indiana)	Whiting, Ind.	Outside Battery Limit Facilities	.....	.....	Under Constr.	1949	.....	Fluor	Fluor
Standard Oil Co. (Ohio)	Cleveland, Ohio	Houdry Cat. Change	.....	$450,000	Under Constr.	Jan., 1950	.....	.....	.....
*Standard (Ohio)	Cleveland, Ohio	Cat. Crk. Expansion	8,000 bbls.	.....	.....	Jan., 1951	.....	.....	.....
Standard (Ohio)	Lima, Ohio	Inc. Tank. Cap.	384,000 bbls.	$240,000	Under Constr.	May 1, 1950	.....	Staff	Hammond
Standard (Ohio)	Lima, Ohio	Liquid Gas Plt.	.....	$220,000	Under Constr.	Dec. 31, 1949	.....	Staff	Undetermined
Standard (Ohio)	Lima, Ohio	Furfural Refg.	76,000 gals.	$13 million	Contracted	1951	Texaco	Lummus	Lummus
Standard (Ohio)	Lima, Ohio	Crd. Dist. Coke	†15,000 bbls.	$5.5 million	Under Constr.	Feb., 1950	Kellogg	Kellogg	Kellogg
Standard (Ohio)	Lima, Ohio	Solvent Dewax.	1,800 bbls.	.....	Under Constr.	Mid., 1950	Texaco	Lummus	Lummus
Standard (Ohio)	Lima, Ohio	Vacuum Unit	9,000 bbls.	.....	Under Constr.	Mid., 1950	.....	.....	Lummus
Standard (Ohio)	Lima, Ohio	Propane, Deasph.	800 bbls.	.....	Under Constr.	Mid., 1950	.....	.....	Kellogg
Sun Oil Co.	Toledo, Ohio	Cat. Crack, Crude Dist., Vac., Poly	30,000 bbls.	$20 million	Under Constr.	Jan., 1950	Houdry	Houdry, Cat. Constr., Process Eng., Staff	Cat. Constr.
Sun Oil.	Toledo, Ohio	Compressor Sta.	3,840 hp.	.....	Designing	.....	.....	Fluor	.....
The Texas Co.	W. Tulsa, Okla.	Expand, Modernize Refinery	30,000 bbls.	$15 million	Under Constr.	Dec., 15, 1949	.....	Kellogg, Foster Wheeler, U.O.P.	Kellogg, Foster Wheeler
The Texas Co.	Lawrenceville, Illinois	Expand Refinery	†20,000 bbls.	.....	Design	April 1, 1951	.....	Foster Wheeler, Kellogg	Foster Wheeler, Kellogg
Tide Water Associated Oil Co.	Drumright, Oklahoma	Houdriflow Unit Cat. Cracker	4,500 bbls.	.....	Under Constr.	Late 1949	Houdry	.....	Process Eng.
U. S. Dept. of Interior	Louisiana, Mo.	Demonstration oil-from-Coal	80 bbls.	$5 million	Under Constr.	Feb., 1950	.....	Koppers	Koppers
*Vickers Petroleum Co., Inc.	Potwin, Kans.	Thermal Poly Unit	250 bbls.	$100,000	Authorized	Feb., 1950	U.O.P.	Ref. Eng.	Ref. Eng.
Wood River Oil & Refining Co., Inc.	Hartford, Ill.	Fluid Cat. Cracker	7,500 bbls.	$2.5 million	Under Constr.	Dec., 1949	U.O.P.	Koch	Staff
Wood River Oil & R.	Hartford, Ill.	Vacuum Unit	15,000 bbls.	$700,000	Under Constr.	1949	.....	Koch	Staff
SOUTHWEST									
*Ada Oil Co.	Houston, Texas	Loading Sta.	.....	.....	Under Constr.	Nov., 1949	.....	Bellco	.....
Alba Refg. Co.	Alba, Texas	Asphalt Refining	1,500 bbls.	$125,000	Under Constr.	Nov., 1949	.....	.....	.....
Amarillo Oil Co.	Exell, Texas	Compressor Sta. Exten.	600 hp	.....	Completed	.....	.....	Staff	Bowden
Calumet Refg. Co.	Princeton, La.	Blending Oil Tank House	700 bbls.	.....	Under Constr.	1st Qtr., 1950	.....	Staff	Staff
Carthage Hydrocol, Inc.	Brownsville, Texas	Hydrocol	87,000 mcf	$26 million	Under Constr.	Dec., 1949	Hydro-Res., Inc. Texaco	McKee, Hyrdo-Res., Inc.	McKee
Cities Service Oil	Chico Field, Tex.	Natl. Gaso. Plt.	22,000 mcf	.....	Designing	Early 1950	.....	Fluor	Fluor
Cities Service Oil	St. Rose, La.	Lube Oil Blending	4,000 bbls.	$750,000	Under Constr.	Late 1949	.....	Day & Zimmerman	Day & Zimmerman
Constal Refineries, Inc. & Mayfair Minerals, Inc.	McAllen, Texas	Cycling Plant	75,000 mcf	.....	Under Constr.	Mar., 1950	.....	Gaso. Plant	Gaso. Plant
Continental Oil Co.	McAllen, Texas	Gaso. Plant	20,000 mcf	$1.5 million	Under Constr.	Dec., 1949	.....	.....	J. & L. Constr.
Continental	Big Lake, Todd (Deep) Field, Texas	Gas Recovery Plant	10,000 mcf	$3 million	Completed	.....	.....	Ref. Maint.	Ref. Maint.
*Continental	20 mi. N. Rio Grande, Texas	Gaso. Plt. Enlargement	†7,000 mcf	.....	Under Constr.	Feb., 1950	..	J. & L. Constr.	J. & L. Constr.
Continental& Assocs..	Near Nordheim, DeWitt County, Texas	Gas Comp.	12,000 mcf	$1 million	Under Constr.	Dec., 1949	None	Process Eng.	Process Eng.
Conden Pet. Corp.	Big Spring, Tex.	Fluid Cat. Plt.	6,000 bbls.	$2 million	Completed	.....	U.O.P.	U O.P.	Ref. Eng.
Del Rey Petroleum Co.	Chesterville, Colorado County, Texas	Pressure Absorp tion Plant	25,000 mcf	.....	Under Constr.	.....	.....	O. L. Olson	Ole Olson
Department of the Army	Houston, Texas	Anhydrous Ammonia Facility	2,100 tons monthly	$2.5 million	Relocating	4th Qtr., 1949	.....	Girdler Corp.	Hercules Powder Co.
Dow Chemical Co.	Freeport, Texas	Ammonia Plant	100 tons	$3 million	Planning	Late 1950	.....	.....	.....
Dow Chemical	Freeport, Texas	Chlorine Addition	.....	.....	Under Constr.	Late 1949	.....	Staff	Tellepsen
El Paso Natural Gas Co.	Mohane Field, Texas	Gasoline Plant	16,700 mcf	.....	Under Constr.	Dec., 1949	.....	Fluor	Staff
El Paso Natural Gas.	Mohane Field	Treating Plant	.....	.....	Under Constr.	Dec., 1949	.....	Fluor	Staff
El Paso Natural Gas.	Moore County, Texas	Compressors	10,600 hp.	$1.8 million	Under Constr.	Jan., 1950	.....	Staff	.....
El Paso Natural Gas.	Moore County, Texas	Gas Dehydration adds.	130,000 mcf	$55,000	Under Constr.	Jan., 1950	.....	Stearns-Roger	Staff
El Paso Natural Gas.	Castro County, Texas	Compressor Sta.	4,050 hp.	$1.1 million	Under Constr.	Jan., 1950	.....	Staff	Staff
El Paso Natural Gas.	Crane County, Texas	Compressor Sta.	4,400 hp.	$1.27 million	Under Constr.	Jan., 1950	.....	Staff	Staff
El Paso Natural Gas.	Ector County, Texas	Compr. Unit	3,200 hp.	$550,000	Under Constr.	Jan., 1950	.....	Staff	Staff

TABULATION OF REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
E. I. DuPont de Nemours Co., Inc.	Victoria, Texas	Chemical Intermediate for Nylon			Design	Early 1951		Staff	Staff
Esso Standard Oil Co.	Baton Rouge, La.	Main Office, Cafeteria, Crude Desalting Unit				May, 1950		Rodman & Murrell, Staff	Staff
Ethyl Corp.	Baton Rouge, La.	Mfg. Facilities		$40 million	Under Constr.	4th Qtr., 1949		Stone & Webster	Stone & Webster
*Evangeline Refining Co.	Jennings, La.	Perco Cycloversion	400 bbls.		Under Constr.	4th Qtr., 1949		Grebe & Doremus	Mason
Humble O&R Co.	Katy, Texas	Add Propane, Absorp., Refrig.	Unchanged		Under Constr.	Jan., 1950		Stearns-Roger	Stearns-Roger
Humble O&R	Conroe, Texas	Absorption	30,000 mcf		Completed			Stearns-Roger	Stearns-Roger
Humble O&R	Opelousas, La.	Absorption	110,000 mcf		Completed			Hudson	Hudson
Humble O&R	Baytown, Texas	Roof Replacing of Butyl Bldg.			Under Constr.	Feb., 1950		Staff	Tellepsen
Humble O&R	Baytown, Texas	Misel. Facilities		$1 million	Projected				
Humble O&R	Jourdanton Field, Texas	Gasoline Plant	26,000 mcf		Under Constr.	Early 1950			Hudson
Humble O&R	Tomball Field, Texas	Add Compression Facilities	10,000 mcf		Completed			Fluor	Fluor
*Humble O&R	Baytown, Texas	Research Bldg.			Under Constr.	Aug., 1950		Voorhees-Walker	Knutson
*Humble O&R	Baytown, Texas	Mech. Maint. Bldg.			Under Constr.	Oct., 1950		Ferguson	Bellows
Jefferson Chem. Co., Inc.	Austin, Texas	Central Research Facilities			Completed			Staff	Staff
Lone Star Gas Co.	Dallas, Texas	Hypersorption	60 mcf		Design & Eng.	1949	Union Oil Co.	Foster Wheeler	Foster Wheeler
Magnolia Pet. Co.	Beaumont, Tex.	Two Houdry's to T.C.C.	30,000 bbls.		Authorised	Late 1950			Lummus
Magnolia Pet.	Seeligson Field, Fremont, Texas	Gasoline Cycling Cycled	150,000 mcf		Under Constr.	Nov., 1949		Hudson	Hudson
*Magnolia Pet. (Operator) et al	Lolita-La Ward, Jackson County Texas	Comp. Sta.	15,000 mcf		Under Constr.	Feb., 1950		West	West
*Mathieson Chem. Co.	Pasadena, Texas	Fertilizer Plt.			Under Constr.	1950		Owner	
Mayfair Minerals	McAllen, Texas	Cycling Plant	50,000 mcf		Under Constr.	Mar., 1950		Gaso. Plant	Gaso. Plant
Midland Gasoline Co.	Conroe, Texas	Enlarge Gasoline	100,000 gals.		Under Constr.	Dec., 1949		Gaso. Plant	Gaso. Plant
*Northern Nat. Gas Co.	White Deer, Texas	2 Comp. Stas.	60 hp., 900 hp.			Dec., 1949		Staff	Dresser
Pan American Refining Corp.	Texas City, Tex.	Revamping Crude Unit			Under Constr.	Late 1949		Tellepsen	Tellepsen
Pan Am. Refg.	Texas City, Tex.	Desulfo Unit		$250,000	Under Constr.	Early 1950		Tellepsen	Tellepsen
*Pan Am. Ref. Corp.	Texas City, Tex.	Lab., Pilot Plt.			Under Constr.	Spring, 1950		Ferguson	Ferguson
Panhandle Producing & Refining Co.	Wichita Falls, Texas	Cat. Cracker	1,500 bbls.	$1 million	Under Constr.	Jan. 1, 1950	U.O.P.	U.O.P., J. & L. Constr.	J. & L. Constr.
*Petrol Refining, Inc.	Texas City, Tex.	Refinery	60,000 bbls.		Shut-down				
Phillips Chemical Co.	Etter, Texas	Prod. of Nitric Acid	225 tons		Under Constr.	Nov., 1949	Chemico	Chemico	Brown & Root
Phillips Chemical	Etter, Texas	Fertilizer Plant	300 tons		Under Constr.	4th Qtr., 1949	Chemico	Chemico	Brown & Root
Phillips Chemical	Borger, Texas	Increase Cap. Phil-black Carbon Black Plant	8 mln. lbs. yr.		Under Constr.	Dec., 1949		Staff	
Phillips Chemical	Etter, Texas	Inc. Cap. Cactus Ammonia Plant	440 tons	$5.3 million	Under Constr.	4th Qtr., 1949	Chemico	Chemico	Brown & Root
Plymouth Oil Co.	Rankin, Texas	Gas Compression, Absorp.	70,000 mcf	$5½ million	Under Constr.	1949-50			Hudson
*Plymouth Oil Co.	Benedum Field, Texas	Nat. Gaso. Plt.		$7 million	Completed				
The Pure Oil Co.	Dollarhide, Andrews County, Texas	Nat. Gasoline Plant	22,000 mcf	$6 million	Under Constr.	July, 1950			
The Pure Oil Co.	Nederland, Tex.	Barge Dock Repair			Under Constr.	Late 1949		Staff	Tellepsen
The Pure Oil Co.	Nederland, Tex.	Wax Plt. Add.			Under Constr.	Early 1950		Staff	Tellepsen
The Pure Oil Co.	Nederland, Tex.	Wax Fractntn.	200 bbls.		Under Constr.	4th Qtr., 1949	Texaco	Lummus	Lummus
Reno Oil Co.	Holiday, Texas	Gaso. Press. Maint. Plant	400 hp.		Under Constr.	4th Qtr., 1949	None	O. L. Olson	O. L. Olson
The Shamrock Oil & Gas Corp.	Sunray, Texas	Inc. Top., Crk.	10,000 bbls.	$300,000	Under Constr.	4th Qtr., 1949	U.O.P.	Staff	Staff
The Shamrock Oil & Gas	Sunray, Texas	Cycloversion Unit	1,500 bbls.	$300,000	Under Constr.	Early 1950	Perco	Staff	Staff
Shell Oil Co.	Houston, Texas	Lube Utilities			Under Constr.	1949		Fluor	
Shell Oil Co.	Provident City, Texas	Gas Stripping	60,000 mcf		Under Constr.	1st Qtr., 1950		Fluor	Fluor
Shell Oil Co.	Notrees, Texas	Add TXL Plant	30,000 mcf		Under Constr.	Early 1950		Brown & Root	Brown & Root
Shell Oil Co.	Denver City, Texas	Gas Comp. Absorp. Add.	30,000 mcf		Under Constr.	Late 1949		Fluor	Fluor
Southern Minerals Corp.	Stratton Field, Texas	Gas Compression addition			Under Constr.				
Stanolind O&G Co., Opr.	Fullerton Field, Texas	Gasoline Plant	55,000 mcf		Under Constr.	Jan., 1950		J. & L. Constr.	J. & L. Constr.
Stanolind Oil & Gas Co.	Alvin, Texas	Dehydration, Gas Sales Plt.			Under Constr.	Dec., 1949		Staff	Tellepsen
Stanolind O&G	Brownsville, Tex.	Chemical Plant	150 tons		Under Constr.	Jan. 1, 1950		Badger	Badger
Stanolind O&G	Levelland, Tex.	Gasoline Plant	40,000 mcf		Under Constr.	Feb., 1950		Brown & Root	Brown & Root
Stanolind O&G	N.Cowden, Tex.	Gasoline Plant	50,000 mcf		Under Constr.	1950		Stearns-Roger	Stearns-Roger
Sun Oil Co.	Starr Co., Tex.	Gasoline Plant	35,000 mcf	$4 million	Completed		Pet. Eng.	Pet. Eng.	Pet. Eng.
Sun Oil	Chambers County, Texas	Compressor Plant	14,000 mcf		Completed				Pritchard
Tex. Natl. Gas Corp. & Slick-Urschel	Rankin, Texas	Nat. Gasoline Plant	55,000 mcf		Under Constr.	Dec., 1949		Tex. Natl. Gas Corp.	Pritchard
*Texas Nat. Gaso. Corp. & Slick-Moorman Oil Co.	Grandfalls, Pecos County Texas	Nat. Gaso. Plt.	30,000 mcf		Under Constr.	Jan. 1, 1950		TNGC Staff	TNGC Staff
The Texas Co.	Tijerina-Canales Field, Texas	Gas Compression	3,000 mcf		Under Constr.	July, 1950			
United Gas Pipe Line Co.	Karnes City, Texas	Nat. Gas., Condensate Process	10,000 mcf	$1 million	Under Constr.	Jan., 1950		Delta	Delta
ROCKY MOUNTAIN									
Coronado Gas Corp.	Loco Hills Field, N. M.	Repressuring, Extraction	10,000 mcf	$500,000	Under Constr.	Dec., 1949	Pet. Eng.	Pet. Eng.	Pet. Eng.
El Paso Nat. Gas Co.	Lea County, N. M.	Compressor Sta.	5,500 hp.	$1.35 million	Under Constr.	Jan., 1950		Staff	Staff
El Paso Nat. Gas		Gas Purif. Plt.	50,000 mcf	$325,000	Under Constr.	Jan., 1950		Stearns-Roger	Staff
El Paso Nat. Gas		Gaso. Absorp. Plant	50,000 mcf	$285,000	Under Constr.	Jan., 1950		Stearns-Roger	Staff
Empire State Oil Co.	Thermopolis, Wyo.	Crude, Vacuum	5,000 bbls.	$325,000	Under Constr.	1949		Ref. Eng.	Ref. Eng.
Frontier Refining Co.	Cheyenne, Wyo.	Coking, 2 Coke Crks.	2,400 bbls.	$725,000	Contracted	May, 1950	U.O.P.	Ref. Eng.	Ref. Eng.

● CONTINUED ON PAGE 91

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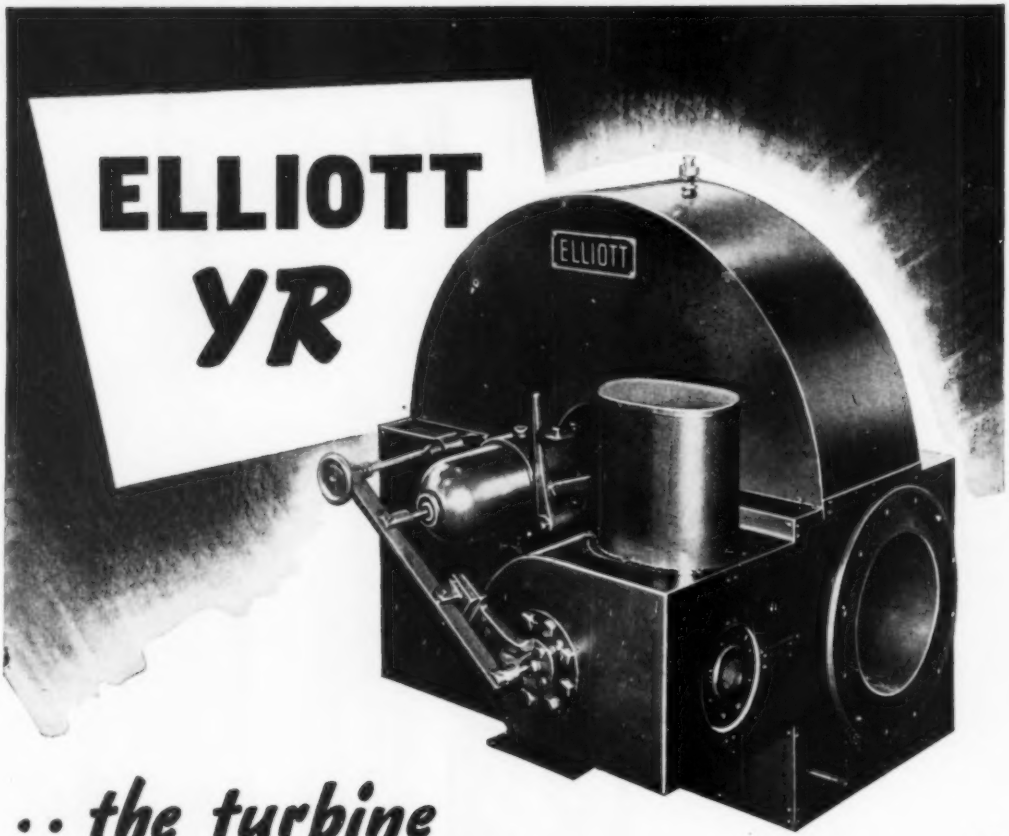

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DISTRICT OFFICES IN PRINCIPAL CITIES

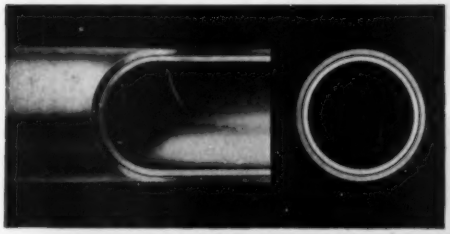
TABULATION OF REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Northern Natural Gas Co.	Palmyra, Neb.	Compressor Add.	1,600 hp.	.....	Under Constr.	1949	.....	.....	Fluor
The Pure Oil Co.	Worland, Wyo.	Gasoline Plant	.....	.....	Projected	.....	.....	.....	.....
Salt Lake Refining Co.	Salt Lake City	Cat. Cracking	25,000 bbls.	$10 million	Design	Jan., 1951	Houdry	Bechtel-Houdry	Bechtel
*Sioux Oil Co.	Newcastle, Wyo.	Thermal Crk.	1,200 bbls.	$300,000	Authorized	Early 1950	U.O.P.	Koch	Staff
Socony-Vacuum Oil Co.	Casper, Wyo.	Topp. Revisions	5,900 bbls.	.....	Under Constr.	Fall, 1949	.....	Staff	Cat. Constr.
*Stanolind Oil & Gas Co.	Eunice, N.M.	Storage Loading Rack	8,000 bbls.	.....	Under Constr.	Dec., 1949	.....	Staff	Dresser
Texas Gulf Sulphur Co.	Worland, Wyo.	Sulfur Recov., Gas Treat. Pits.	30,000 mcf	.....	Under Constr.	.....	.....	Girdler, C. F. Braun, Foster Wheeler	Girdler
WEST COAST									
*Continental Oil Co.	Ventura, Calif.	Rev. to Gaso. Pit.	20,000 mcf	.....	Under Constr.	May, 1950	.....	Ref. Maint.	Ref. Maint.
*Coline Gasoline Co.	Ventura, Calif.	Rev. to Gaso. Pit.	20,000 mcf	.....	Under Constr.	Dec., 1949	.....	Ref. Maint.	Ref. Maint.
General Pet. Corp.	Torrance, Calif.	H_2S Absorption	.....	.....	Engineering	Jan., 1950	.....	Badger	Badger
General Pet. Corp.	Torrance, Calif.	Noded Spheroid	2 million gal.	$400,000	Completed	.....	.....	Staff	C.B.&I.
General Pet. Corp.	Torrance, Calif.	Cooling Tower	8,400 gal.	.....	Completed	.....	.....	Staff	Fluor & Staff
General Pet. Corp.	Torrance, Calif.	Chemical Treat.	2,000 tons	.....	Under Constr.	4th Qtr., 1949	.....	Staff	Staff
General Pet.	Torrance, Calif.	Two Coke Drums, Furnace	7,500 bbls.	$2.25 million	Under Constr.	Early 1950	.....	Kellogg, Staff	Bechtel
Hancock Chemical Co.	Long Beach, Cal.	H_2S Recovery	50 tons	$1 million	Designing	Jan., 1950	.....	Badger	Badger
Hancock Oil Co.	Long Beach	Ethylene Glycol	60,000 lbs.	.....	Engineering	3rd Qtr., 1950	.....	Badger	Badger
Ohio Oil Co.	S. Coles, Levee, Calif.	Gas Lift	1,800 hp.	.....	Under Constr.	Nov., 1949	.....	Fluor	Fluor
Paloma Refining Co.	Paloma Field, Calif.	Extend Absorption Sect.	60,000 mcf	.....	Planning	.....	.....	.....	.....
Richfield Oil Corp.	Cuyama, Calif.	Absorption H_2S Removal	15,000 mcf	.....	Under Constr.	1949	.....	Fluor	Fluor
Richfield Oil Corp.	Cuyama, Calif	Comp. Plt. Extn.	2,640 hp.	.....	Designing	1949	.....	Fluor	Fluor
Shell Oil Co.	Wilmington, Cal.	Add. Crk. Comp.	.....	.....	Under Constr.	1949	.....	Fluor	Fluor
Standard Oil Co. of Calif.	Bakersfield, Cal.	Ther. Crk. Gaso. Stabil., Treat.	9,000 bbls.	.....	Under Constr.	Late 1949	U.O.P.	U.O.P.	Braun
Standard Oil, Calif.	Bakersfield, Cal	Crude Dist.	10,000 bbls.	$7.7 million	Completed	.....	Braun	Braun	Braun
Union Oil Co. of Calif.	Brea Olinda, Cal.	Research Plant	.....	$3 million	Projected	Sept., 1950	.....	.....	.....
Union Oil of Calif.	Oleum, Calif	Revise Refg.	.....	$4 million	Under Constr.	Dec., 1949	.....	Parsons, E. & A.	Ref. Maint.
Union Oil of Calif.	Oleum, Calif.	Improve handling facilities	.....	$1.5 million	Under Constr.	Dec., 1949	.....	Mathews, Montgomery	Early, C. N. Peterson, Mathews
Union Oil of Calif.	Oleum, Calif.	Tankage and Utilities	.....	$1.8 million	Engineering	1st Qtr., 1950	.....	Parsons	Eaton & Smith, C.B.&I., Utah
Union Oil of Calif.	Oleum, Calif.	Main Office Addition, Shops, Misel.	.....	$1 million	Under Constr.	Dec., 1949	.....	Austin, Field & Fry, D. R. Warren Co., Montgomery	E. S. McKittrick, Parker, Steffens & Pearce
*Union Oil Co.	Oleum, Calif.	Add. Ref. Facilities	.....	.....	Under Constr.	Feb., 1950	.....	.....	.....
FOREIGN									
Canada									
British American Oil	Montreal East, Quebec	Cat. Crk., Poly.	13,300 bbls.	.....	Completed	.....	Kellogg-U.O.P.	Kellogg	Kellogg
*British-American Oil Co.	Edmonton, Alberta	Refinery	2 mln. yr.	.....	.....	.....	.....	.....	.....
Excelsior Refs., Ltd.	Lloydminster, Alberta	Cap. Increase	3,000 bbls.	.....	Under Constr.	1950	U.O.P.	U.O.P.	.....
*Excelsior Refs., Ltd.	Lloydminster, Alberta	Capacity Inc.	1,500 bbls.	.....	Design	1950	.....	.....	.....
Hi-Way Refineries, Ltd.	Saskatoon, Saskatchewan	Crude Topping Unit	2,000 bbls.	.....	Under Constr.	Jan., 1950	U.O.P.	Ref. Eng.	Ref. Eng.
Hi-Way Refineries	Saskatoon	Thermal Crack.	500 bbls.	.....	Under Constr.	Jan., 1950	U.O.P.	Ref. Eng.	Ref. Eng.
Imperial Oil, Ltd.	Leduc Field	Gas Absorption	24,000 mcf	$6.5 million	Under Constr.	Mid. 1950	.....	Braun	Braun
Imperial Oil	Regina, Saskatchewan	Add Distil. Equip.	3,000 bbls.	$380,000	Under Constr.	Jan., 1950	.....	Staff	Staff
*Imperial Oil	Winnipeg, Cdn.	New Refinery	.....	.....	Planning	.....	.....	.....	.....
Panther Oil and Grease Co.	Leaside, Toronto, Ontario	Grease and Compounding	.....	.....	Projected	.....	.....	.....	.....
Shell Oil Co. of Canada, Ltd.	Montreal East, Quebec	Fluid Cat. Crk., Vac. Flash Gas Recov., Poly, Treat.	35,000 bbls.	.....	Under Constr.	Late 1950	.....	Staff	Fluor, Ltd., McKee
Latin America									
Administracion Nacional Combustible Alcohol y Portland	Montevideo, Uruguay	Lube, Asphalt Units	7,500 bbls.	.....	Under Constr.	1st Qtr., 1950	.....	Foster Wheeler	Foster Wheeler
Conselho Nacional do Petroleo	Mataripe, Bahia, Brazil	Thermal Cracking Refinery	5,000 bbls.	$2.5 million	Under Constr.	Jan., 1950	.....	Kellogg	Kellogg, Staff
*Conselho Nacional do Petroleo	Santos Sao Paulo	Refinery	45,000 bbls.	.....	.....	.....	.....	.....	.....
*Conselho Nacional do Petroleo	Mataripe, Bahia, Brazil	Refinery	.....	$3.5 million	Planning	Dec., 1950	.....	.....	.....
Creole Pet. Corp.	Amuay Bay, Venezuela	Crude Stills	60,000 bbls.	$175 million	Under Constr.	1950	.....	S.O.D.	Foster Wheeler, J. G. White
Creole Pet. Corp.	El Roble Field, Venezuela	Repressuring	.....	.....	Planning	.....	.....	.....	.....
Ipiranga S.A. cia Brasilera de Petroleos	Rio Grande, Brazil	Topping, Thermal Cracking	3,000 bbls.	.....	Authorized	1952	Foster Wheeler	.....	.....
Mene Grande Oil Co.	Puerto la Cruz, Venezuela	Refinery	30,000 bbls.	.....	.....	.....	.....	.....	.....
Petroleos Mexicanos	Posa Rica, Mex.	Gas Purification. Pressure Maint.	.....	$13 million	Contracted	Early 1950	.....	McKee	McKee
Petroleos Mexicanos	Salamanca, Mex.	Crd.,Gasoil, Crk.	25,000 bbls.	$12 million	Under Constr.	Early 1950	U.O.P.	McKee	McKee
Refinaria de Petroleo do Distrito Federal S.A.	Rio de Janeiro, Brazil	Complete Refinery	45,000 bbls.	.....	Authorized	.....	.....	.....	Fives, Lille, Schneider, Staff
Refinaria e Exploracao de Patroleo Unisa S.A.	Capuava, Sao Paulo, Brazil	Thermal Cracking Refinery	20,000 bbls.	.....	Authorized	.....	.....	Pan American Hydrocarbon Res., Inc.	Czech, Fact. Metal Work Mech. Constr.
Richmond Exploration Co.	Bajo Grande, Venezuela	New Refinery	35,000 bbls.	.....	Engineering	June, 1950	.....	.....	.....
Shell Caribbean Pet. Co.	La Paz, Venezuela	Gas Plant	90 tons	.....	Under Constr.	Early 1950	.....	.....	.....
Shell Caribbean Pet. Co.	Mara, Venezuela	Gas Plant	90 tons	.....	Projected	Early 1951	.....	.....	.....
Shell Oil of Venezuela	Punta Cardon, Venezuela	Comprehensive Refining	50,000 bbls.	$32 million	Under Constr.	Mid 1951	.....	.....	.....

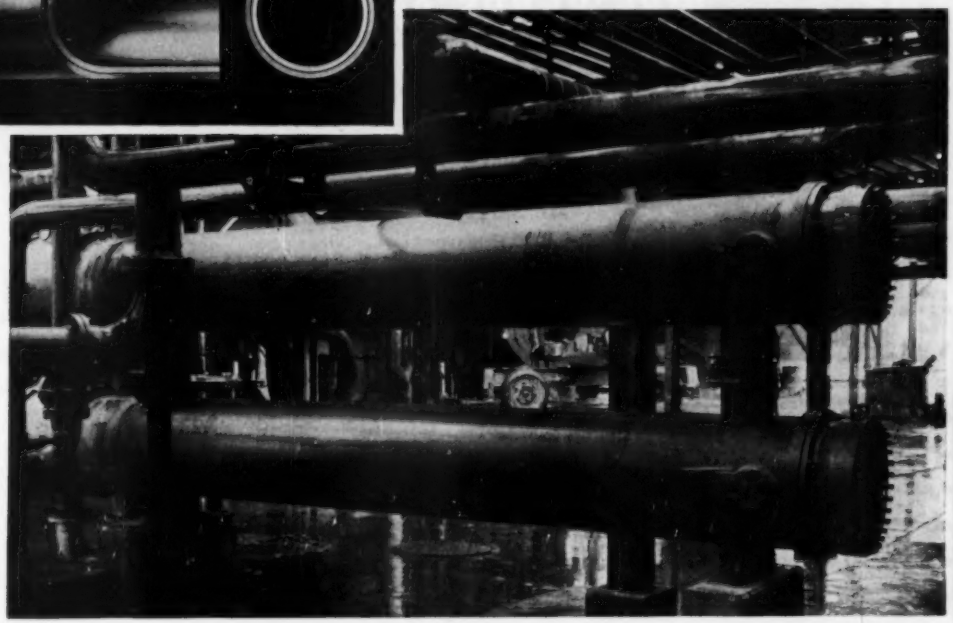
TABULATION OF REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Venezuela Gulf Refining Co.	Puerto la Cruz, Venezuela	Refinery	30,000 bbls.	$5 million	Under Constr.	July, 1950		Lummus	Lummus
Venezuelan Pet. Co.	Puerto la Cruz, Venezuela	Refinery	35,000 bbls.		Under Constr.			Snare	Snare
Yacimientos Petroliferos Fiscales	Buenos Aires, Argentina	New Refinery	28,000 bbls.	$54 million	Engineering	Late 1950		Kellogg	Kellogg
YPF	La Plata, Argentina	Crude Topping, Gaso Treating	50,000 bbls.	$2.8 million	Under Constr.	1949		Houdry Process Cat. Constr.	Cat. Constr.
YPF Bolivianca	Cochabamba, Bolivia	Topping & Reforming Units	5,000 bbls.			3rd Qtr., 1950		Foster Wheeler	Foster Wheeler
Europe and Africa									
Anglo-American Oil Co.	Fawley, Eng.	Refinery Expansion	110,000 bbls.	$150 million	Under Constr.	Late 1952		Foster Wheeler	Foster Wheeler
*Anglo American	Fawley, Eng.	SO_2 Extraction	13,000 bbls.		Design			Badger	Badger
Anglo-Iranian Oil	Isle of Grain, Eng.	Cent. Refg. Unit	60,000 bbls.	$120 million	Planning	1952			
Anglo-Transvaal Consolidated Investment Co.	Vall River, Union of South Africa	Synthetic Gasoline and Diesel Oil Plant		$50-60 million	Contracted			Hydrocarbon Research	
*Aquila, S.A.	Trieste, Italy	Lube Oil Refinery	100 tons		Design	Mar., 1951	Juik, Texaco	Badger	Badger
Azienda Generale Italiana Petroli	Rome, Italy	Add to Plant	24,000 bbls.		Projected	Late 1951			
Azienda Generale Italiana Petroli	Palermo, Italy	Marine Fuel Plant	7,500 bbls.						
Bataafsche Petroleum Mij.	Pernis, Holland	P.U.C. Plant	2,000 tons, yr.			Jan., 1950			
My. Bataafsche Pet.	Pernis, Holland	Expansion	50,000 bbls.		Under Constr.	Mid 1952			
*British Petroleum Chem.	Grangemouth, Scotland	Petrochem			Under Constr.	Dec., 1950		Badger	Badger
Cabot Carbon, Ltd. (Godfrey L. Cabot, Inc.)	Ellesmere Port, Eng.	Carbon Black Plant	50,000 lbs., yr.		Under Constr.	1950		Simon-Carves, Ltd.	Simon-Craves, Ltd.
Caltex Pet. Maatschappij, N.V.	Rotterdam, Holland	Complete Refinery	20,000 bbls.	$18 million	Under Constr.	Feb., 1950		McKee, Badger, U.O.P.	McKee
Cie. de Raffinage Shell-Berre	Berre, France	Expansion	40,000 bbls.		Under Constr.	Mid 1951			
Shell	Petit-Couronne	Teepel Plant	25,000 tons, yr.			Mid 1950			
Cie. de Raffinage Shell-Berre	Petit Couronne, France	Lube Unit			Planned				
Cie. de Raffinage Shell-Berre	Petit-Couronne (Rouen), France	Expansion	10,000 bbls.		Under Constr.	Early 1950			
Cie. Francaise de Raffinage	Gonfreville, France	Lube Unit	2,500 bbls.		Projected	1951	Texas	Kellogg-Lummus	
Cie. Francaise de Raffinage	Gonfreville, France	Distillation Unit	20,000 bbls.		Under Constr.	1950		Foster Wheeler	Foster Wheeler
Cie. Francaise de Raffinage	Provence, France	Topping Unit	20,000 bbls.	$11 million	Under Constr.	1950		Foster Wheeler	Foster Wheeler
*Cia Espanola de Petroleos, S.A.	Sta. Cruz de Tenerife (Canary Islands)	Propane-Butane Fractionating, Propane-Deasphalting	304 bbls.	$100,000	Contracted	June-July, 1950		U.O.P.	U.O.P.
*Cia Espanola de Petroleos, S.A.	Sta. Cruz de Tenerife Canary Islands)	Propane-Butane Fractionating, Propane-Deasphalting	700 bbls.	$300,000	Contracted	June-July, 1950	Standard Oil	Foster Wheeler	Foster Wheeler
Cia. Espanola de Petroleos S.A. (C.E.P. S.A.)	Canary Islands, Spain	Furl. Ref. Sol. Dewax., Wax Fractntn.	5,000 bbls.	$4.5 million	Under Constr.	Early 1950	Texaco, Standard, N.J.	Foster Wheeler	Foster Wheeler
Condor, S.P.A. Per l Industrial Pet. e Chemica	Rho, Italy	New Refinery	1 mln tons/yr.						
Danish Government	Denmark	Refinery	21,000 bbls.		Planned				
Egyptian Government	Cairo, Egypt	Crude Plant						Lummus	Lummus
Industrie Chimiche Italiane Petroli	Mantua, Italy	Crude	4,500 bbls.						
Industria Nazionale Petroli e Trasformaziche	Massa Carrara, Italy	Refinery	40,000 bbls.			Late 1951			
Industria Petrolifera e Chimica	Milan, Italy	Gasoline Fuel Oil Plant	20,000 bbls.					Dr. Calogero Inglogio	
Imperial Chemical Industries, Ltd.	Wilton, Yorkshire, England	Petroleum Cracking Unit			Under Constr.	1950		Kellogg	Kellogg
Koppartrans Co.	Gotelberg, Swe.	Ref. Ther. Crk.	12,500 bbls.		Completed			Lummus	Lummus
Stand.-Azienda Gen. Indro. Comb. (Stanic)	Leghorn, Italy	Add Capacity	28,700 bbls.						
Ditto (Stanic)	Bari, Italy	Add Capacity	38,300 bbls.						
L'Alliance Petrofina	Antwerp, Belg.	Refinery	21,000 bbls.		Planned				
Manchester Oil Refinery, Ltd.	Partington, England	Cat. Crk., Lube Reforming	20,000 bbls.		Projected				
Monsanto Chemica Co.	Britain	Add Polystyrene			Design	Early 1950		Staff	Staff
National Oil Refineries, Ltd.	Llandarcy, Wales	Crude and Reform	40,000 bbls.					Badger	Badger
*National Oil Refineries	Llandarcy, Wales	Lube Oil Refinery			Under Constr.		Juik, Texaco	Badger	Badger
National Oil Refineries	Llandarcy, Wales	Furf. Ref. Sol. Dewax, Wax Fractn.	1,200 bbls.	$36 million	Designing		Texaco	Badger	Badger
National Oil Refineries	Llandarcy, Wales	SO_2 Solvent Extraction	3,000 bbls.		Contracted			H.W.P.	
Pechelbronn, S. A. E. M.	Merkwiller, France	Capacity Increase	1,550 bbls.		Authorized	1950			
Petro Carbon, Ltd.	Partington, England	Cat. Cracker, Lube & Reform	20,000 bbls.						
Petro Chem., Ltd.	Partington, England	Petro Chemicals	2,000 bbls.	$16 million	Under Constr.	1949	Petro-Carbon	Petro-Carbon	Petro-Carbon
Philblack, Ltd.	Avonmouth, England	Carbon Blk. Plt.	137,000 bbls.	$5 million	Contracted	1950	Phillips	H.W.P.	H.W.P.
Raf. de Pet. de Escom. S.A.	Cartagena, Spain	Refinery	20,000 bbls.		Under Constr.	July, 1951			
Radfinerie Belge de Petroles S.A.	Antwerp, Belgium	Therm. Crk., Reform., Gas Plant		$2 million	Under Constr.	Late 1949		Barnes	Barnes
Raffineries de Petrole de la Gironde	Fos Ambes, France	Refinery	13,000 bbls.	$7.8 million	Reconstr.	Early 1950		U.O.P., McKee	McKee
Raffineries Francaises de Petrole de l'Atlantique	St. Nazaire, France	Consolidate Refineries	7,100 bbls.	$9.4 million					
Raffineria di Napoli, S.P.A.	Naples, Italy	Visbreaker				Early 1950		Staff	Staff

■ CONTINUED ON PAGE 95



Anaconda Duplex Tubes are manufactured to meet special needs . . . formed usually with seamless copper alloy tube drawn either inside or outside of seamless steel tube.



ANACONDA DUPLEX TUBES resist water-side corrosion at Lake Charles operations of Mathieson Chemical

DUPLEX HEAT EXCHANGER TUBES . . . steel, lined with Anaconda Arsenical Admiralty 439 . . . are successfully withstanding the attack of corrosive river water in the Lake Charles, La. plant of the Mathieson Chemical Corporation.

These tubes are employed in two heat exchangers recently built by the Alco Products Division, American Locomotive Company at their Beaumont, Texas plant, to handle 134,000 lb. per hr. of ammoniacal copper acetate on the shell side and 212,000 lb. of river water per hr. through the tubes.

Anaconda Duplex Tubes are special purpose tubes, designed to meet specific requirements, but are available in a wide range of sizes, gages and alloys. The nonferrous tube may be drawn either inside or outside of the steel tube, or Duplex Tubes may be fabricated from two different nonferrous alloys.

Our Technical Department, with its wide experience in solving many kinds of tube problems and its extensive laboratory facilities, is at your service at all times. For further information, write for Publication B-2.

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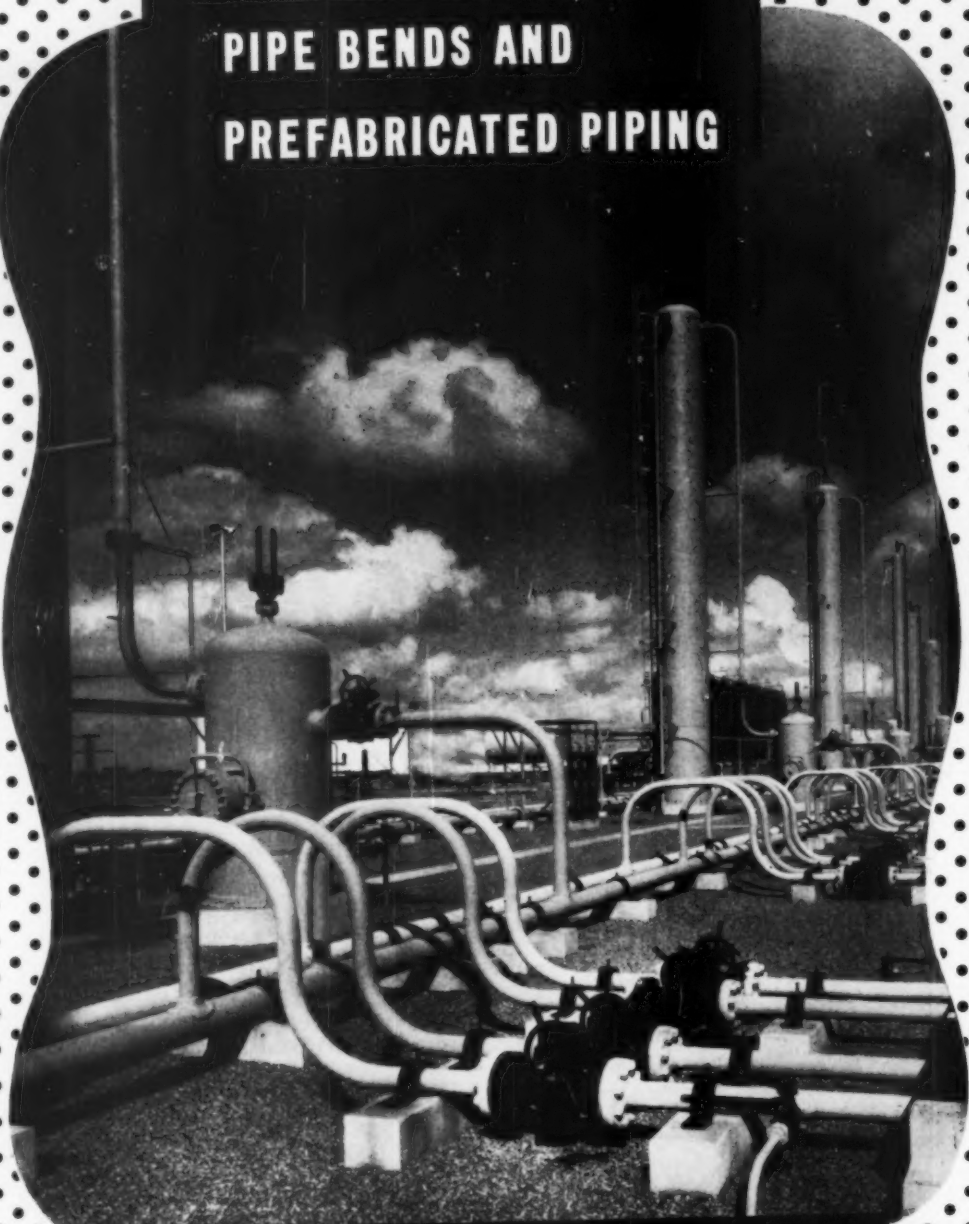

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TABULATION OF REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Raffineria di Napoli, S.P.A.	Naples, Italy	Topping Unit	15,000 bbls.	.....	Under Constr.	Late 1949	.....	Staff	Staff
Raffineria di Napoli.	Naples, Italy	Solvent Treating	1,000 bbls.	.....	Under Constr.	Dec., 1949	Texaco	Staff	Staff
Raffineria di Napoli.	Naples, Italy	Reformer	5,000 bbls.	.....	Under Constr.	Early 1950	.....	Staff	Staff
Raffinerie Siciliane Olii Minerali, S.A.	Augusta, Sicily	Crude Refinery	10,000 bbls.	.....	Designing	Early 1950	U.O.P.	U.O.P., Delta	S. T. I. I.
Scottish Oils, Ltd.	Grangemouth, Scotland	Crude	28,000 bbls.	$28 million	Designing	.....	.....	Kellogg	Kellogg
Scottish Oils, Ltd.	Grangemouth	Cat Crk.	5,000 bbls.		Planned	.....	.....	.....	.....
Shell Chemical Mfg. Co., Ltd.	Thornton, Eng.	Teepol Plant Extension	75,000 tons per Year	.....	Under Constr.	Jan., 1950	.....	.....	.....
Shell Refining & Marketing Co., Ltd.	Stanlow, Eng.	Comprehensive Refining	60,000 bbls.	.....	Under Constr.	Early 1952	.....	.....	.....
Shell Refining & Marketing Co., Ltd.	Shell Haven, England	Comprehensive Refining	40,000 bbls.	.....	Under Constr.	Mid 1953	.....	.....	.....
Shell Refining & Marketing Co., Ltd.	Hamburg-Harburg, Germany	Refinery	8,950 bbls.	.....	Completed	.....	.....	.....	.....
Societe Generale des Huiles de Petrole	L'Avera, France	LPG Units	25,000 bbls.	.....	Under Constr.	Mid 1950	Kellogg	Kellogg	Staff
Societe Generale	Dunkirk, France	Crude Reform.	33,000 bbls.	.....	Under Constr.	Mid 1951	Lummus, Kellogg	Lummus, Kellogg	Lummus, Kellogg
Societe Generale	Dunkirk, France	Furf. Ref. Sol. Dewax., Wax Fractn.	2,400 bbls.	.....	Designing	Mid 1951	Texaco	Lummus	Lummus
Societe Industrial Belgique de Petrele	Antwerp, Belgium	Crude, Cracking Reforming	30,000 bbls.	.....	Designing	Mid 1951	.....	.....	.....
*Societe Raffinazione Olii Minerali (IROM)	Porto Marghera, Italy	Atmospheric & Vac. Distill., Acid Treat., Contact Filtration for Lube Oils, Electric Gen. Unit, Load. Facilities	1,100 mln tons year	$6.4 million	Contracted	.....	.....	H.W.P.	H.W.P.
Societe per Azioni Raffineria Padana Olii Minerali	San Martino di Trecate, Italy	Refinery	13,000 bbls.	.....	Proposed	.....	.....	.....	.....
Socony-Vacuum Francaise	Notre Dame de Gravenchon	MEK Unit	1,000 bbls.	.....	Design	Mid 1950	Texaco	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon	Propane Deasphalting	1,100 bbls.	.....	Design	Mid 1950	Juik	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon	Grease and Compounding	.....	.....	Under Constr.	Mid 1950	.....	Staff	Staff
Standard Francaises des Petroles	Port Jerome, France	Dewaxing Plant	1,000 bbls.	.....	Planned	.....	.....	.....	.....
Standard Francaises des Petroles	Port Jerome, France	Deasphalting Plant	2,000 bbls.	.....	Planned	.....	.....	.....	.....
Standard Oil Co., (N.J.)	Belgium	Dist. Crack.	33,000 bbls.	.....	Planned	Early 1952	.....	.....	.....
Trent Oil Prod Development Co.	North Shields, England	Crude Plant	11,500 bbls.	$4.8 million	Plans approved	.....	.....	.....	.....
Union Petrol Refinery, Ltd.	Johannesburg, Union of South Africa	New Refinery	.....	$20 million	Projected	.....	.....	.....	.....
Near East									
Anglo-Iranian Oil	Abadan, Iran	Gas Plant	25,000 mcf	$2 million	Under Constr.	1950	.....	Badger	Badger
Anglo-Iranian	Abadan, Iran	Cat. Cracker	30,000 bbls.	.....	Under Constr.	1951	.....	Foster Wheeler	Foster Wheeler
Anglo-Iranian	Abadan, Iran	Solvent Dewax.	400 bbls.	.....	Under Constr.	.....	Texaco	Badger	Badger
*Anglo-Iranian	Abadan, Iran	Gas Recov., Stab.	22,000 mcf	.....	Under Constr.	Mar., 1951	.....	Badger	Badger
Arabian American Oil Co.	Abqaiq, Saudi Arabia	Crude Oil Stabilizer	300,000 bbls.	$4.8 million	Under Constr.	Summer 1950	.....	Staff and Fluor	Staff and Fluor
Arabian American	Ras Tanura, S.A.	Ref. Addn.	.....	.....	Under Constr.	1950	.....	Bechtel	Int. Bechtel, Inc.
Arabian American	Ras Tanura, Saudi Arabia	Asphalt Plant	500 bbls.	$1,250	Plans Approved	1950	.....	Staff, Bechtel	Staff
Bahrein Pet. Co., Ltd.	Bahrein Island	Expansion Program	.....	$8.3 million	Under Constr.	4th Qtr., 1949	.....	U.O.P., Bechtel	Int. Bechtel, Inc.
Bahrein Pet. Co., Ltd.	Bahrein Island	Crd. Still Util.	55,000 bbls.	$9.1 million	Under Constr.	Aug., 1950	.....	Lummus, Bechtel	Int. Bechtel, Inc.
Consolidated Ref., Ltd.	Haifa, Palestine	Crude Plant	80,000 bbls.	.....	Planned	Late, 1951	.....	Badger	Badger
Consolidated Ref., Ltd.	Haifa, Palestine	Gen. Facilities	.....	.....	Under Design	.....	.....	Badger	.....
Consolidated Ref., Ltd.	Haifa, Palestine	Lube Plant	2,500 bbls.	.....	Designing	.....	Texaco, Juik	Lummus, Kellogg	Lummus, Kellogg
Far East									
Bataafsche Pet. Mij. (Shell)	Balirpapan, Borneo, East Indies	Expansion	42,000 bbls.	.....	Under Constr.	Mid 1952	.....	.....	.....
Bataafsche Pet. Mij.	Pladjoe, Sumatra	Rehab. to Comprehensive Refg.	70,000 bbls.	.....	Under Constr.	Mid 1951	.....	.....	.....
Burmah Oil Co., Ltd.	Syriam, Burma	Furf., Sol. Dewax., Wax Mfg.	1,000 bbls.	$600,000	Designing	.....	Texaco	Badger	.....
Burmah Oil Co.	Syriam, Burma	Thermafor Clay Revivification	66 tons	$150,000	Design	1949	Max Miller, Socony-Vacuum	Max Miller	.....
Oceania									
Australian Shell Oil Co.	Clyde, New S. W., Australia	Luboil Refining	250 bbls.	.....	Under Constr.	Late 1950	.....	.....	.....
Australian Shell Oil Co.	Geelong, Victoria, Australia	New Refinery	.....	$4.8 million	Under Constr.	Late 1951	.....	.....	.....
Australian Shell Oil Co.	Geelong, Victoria, Australia	Bitumen and Luboil Plant	.....	.....	Projected	.....	.....	.....	.....
Australian Shell Oil Co.	Geelong, Victoria, Australia	Asphalt, Lube Solvent Extraction Plants	.....	.....	.....	.....	.....	.....	.....

* First appearance in tabulation. † Added capacity.

NOTE: Badger—E. B. Badger and Sons. Barnes—W. M. Barnes & Co. Bechtel—Bechtel Corp. Bellows—W. S. Bellows Co. Blaw-Knox—Blaw-Knox Construction Co. Bowden—W. H. Bowden. Braun—C. F. Braun Co. Brown Eng.—Brown Engineering Co. Brown & Root—Brown & Root Construction Co. Cat. Constr.—Catalytic Construction Co. Chemico—Chemical Construction Co. C.B.&I.—Chicago Bridge & Iron Works Co. Clarke—Clarke Construction Co. Constr. Service—Construction Service Co. Delta—Delta Engineering Corp. Dresser—Dresser Engineering Corp. E.&A.—Ehrhart & Arthur, Inc. Ferguson—H. K. Ferguson. Fish Eng.—Fish Engineering Corp. Fluor—Fluor Corp. Foster Wheeler—Foster Wheeler Corp. Gasc. Plant—Gasoline Plant Construction Co. General American—General American Transportation Co. Girdler—The Gridler Corp. Graff—Graff Engineering Co. Grebe & Doremus—Grebe & Doremus Process Co. Hammond—Hammond Iron Works Co. Houdry—Houdry Corp. Hudson—Hudson Engineering Corp. H.W.P.—Head Wrightson Processes, Ltd. Hydro Res.—Hydrocarbon Research, Inc. Ind. Eng.—Industrial Engineers, Inc. J.&L. Constr.—Construction Division, Jones & Laughlin Supply Co. Kellogg—M. W. Kellogg Co. Koch—Koch Engineering Co. Koppers—Koppers Co., Inc. Knowles—Morris Knowles & Co. Knutson—Knutson Construction Co. Leonard—Leonard Construction Co. Lummus—The Lummus Co. Mahoney—Mahoney Contracting Co. Mason—Mason Brothers Construction Co. Mathews—Mathews Conveyor Co. McKee—Arthur G. McKee Co. Max. Miller—Max B. Miller & Co. Montgomery—J. M. Montgomery & Co. Parsons—The Ralph M. Parsons Co. Perco—(Division) Phillips Petroleum Co. Pet. Eng.—Petroleum Engineering, Inc. Petreco—Petroleum Rectifying Co. Pritchard—J. F. Pritchard Co. Process Eng.—Process Engineers, Inc. Process Constr.—Process Construction Co. Ref. Eng.—Refinery Engineering Co. Ref. Maint.—Refinery Maintenance Co., Inc. Rust Eng.—Rust Engineering Co. Rust Pro.—Rust Process Design Co. Schneider—Schneider & Cie. Snare—Frederick Snare Corp. Sollitt—Summer S. Sollitt Co. S.O.D.—Standard Oil Development Co. State Eng.—State Engineering Co. Stearns-Roger—Stearns-Roger Manufacturing Co. Stone & Webster—Stone & Webster Construction Co. Tellepsen—Tellepsen Construction Co. Texaco—Texaco Development Co. U.O.P.—Universal Oil Products Co. Utah—Utah Construction Co. Voorhees, Walker, Foley & Smith. Walco—Walco Engineering. West—F. S. West Construction Co. Wohfeld—Wohfeld Construction Co. Equally owned California Texas Corp. and Socony-Vacuum Oil Co., Inc.

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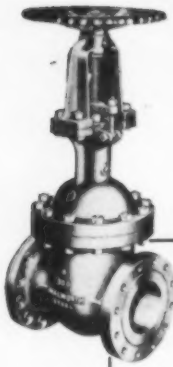
Series 150 and 300

Wedge Gate — Outside Screw and Yoke



Sectional view of Series 300

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Gland clearances are such that stem cannot be scored if gland should be tightened unevenly.

Deep Stuffing Boxes in all sizes (2" to 24") insure tightness and maximum packing life – costly leaks are eliminated.

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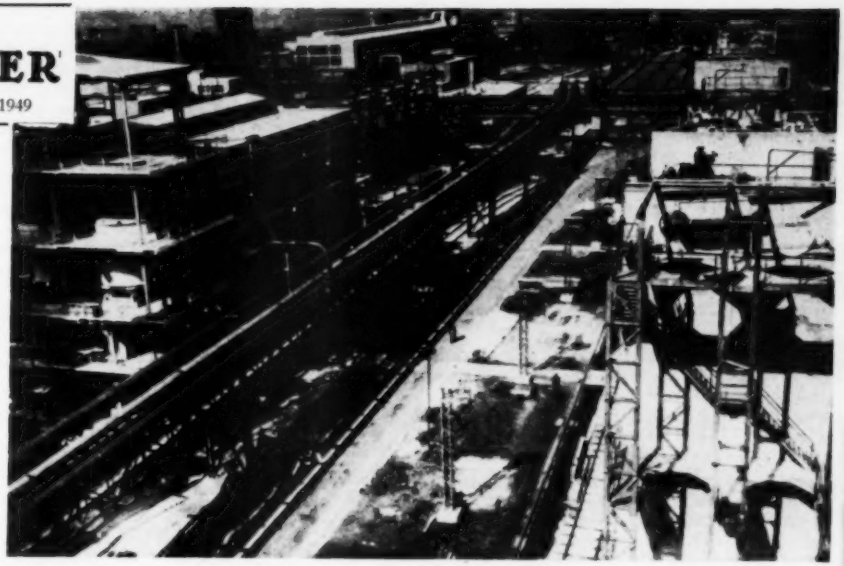


View of the High-Pressure Area in a Hydrogenation Plant.

High-Pressure Hydrogenation Of Carbonaceous Matter

Part 1, Introduction

PETER W. SHERWOOD
Koppers Company, Inc., Pittsburgh, Pa.

PROPER planning for the maintenance of adequate petroleum supplies for the United States must eventually include the construction of a synthetic fuels industry based on coal. High-pressure hydrogenation shows certain advantages over the Fischer-Tropsch process for the manufacture of aviation gasoline, fuel oils, and a number of specialty products.

Part I of this series surveys today's industrial status of the high - pressure hydrogenation process, traces its history, and outlines the flow scheme and some of the major basic considerations.

The series will appear in eight parts.

WHEN, and if, American petroleum supplies are no longer able to keep pace with the ever-growing demand for hydrocarbon products, the nation will be able to turn to three sources to implement her oil resources: Oil shale, natural gas, and coal.

How soon the day will come when the United States must rely on synthetic liquid fuels to supplement her natural petroleum supply is a question which has been argued at fruitless length. But it has become increasingly evident that this country will not be able to stave off the advent of a supplemental source of liquid fuels very much longer. The increase in consumption, the relative decline in petroleum discoveries, and the consequent rise in crude oil prices combine to make the economic outlook for a synthetic fuels industry more and more attractive.

Vast deposits of oil shale are found in the Colorado area. Progress has been reported in the development of methods for their economical exploitation. The problem's successful solution will mean an important contribution to the oil supply of the nation. But still, the economic meaning will be locally limited and the potential extension of the oil resources by this means will be minor.

The short-range solution par excellence to the problem of dwindling oil supplies is the synthesis of liquid fuels from natural gas by the Fischer-Tropsch process. Natural gas, still wasted in many sites, is probably the cheapest large-scale source for synthesis gas and for hydrogen production. The cost of gas production (from coal) represents about 70-80 percent of the total cost of the Fischer-Tropsch synthesis while it accounts for only about 25-30 percent of synthetic fuels costs by the high-pressure hydrogenation process. A cheap source of gas is therefore more efficiently and economically exploited by the Fischer-Tropsch process.

As a broad basis for oil production, natural gas cannot be seriously considered, however. Even if all the natural gas produced annually in the United States were upgraded to gasoline by the Fischer-Tropsch synthesis (an obvious absurdity), the product would account for no more than 15 percent of the nation's 1948 consumption.

Any serious approach to the prob-

lem of synthetic fuels production must therefore look to coal as its main stock. This necessity becomes immediately clear from a comparison of the estimated mineral-fuel reserves of the United States:[1]

	Equivalent Billions of Net Tons Coal at 13,000 Btu./Lb.	Percent of Total Fuel Reserves
Coal	2,556	98.8
Petroleum	4.8	.2
Oil from Shale	21.2	.8
Natural Gas	5.2	.2

A synthetic fuels industry based on coal will look to both the Fischer-Tropsch synthesis and to coal hydrogenation as economically suitable processes.

As sources of hydrocarbons, the two processes are complementary. The Fischer-Tropsch product consists almost solely of straight-chain paraffins and olefins. (The only exception to this is the economically non-competitive "isosynthesis" process which yields branched-chain hydrocarbons.) The process is ideally suited for the production of Diesel oils, lube oils, and paraffin wax. By proper processing, and at a sacrifice in yield, it becomes possible to obtain a Fischer-Tropsch gasoline with a clear octane number of 50-60 and even up to 70. Attempts to upgrade the product even further result in excessive losses and render the process unsound.

The product of high-pressure hydrogenation, on the other hand, is usually of a highly aromatic nature. Octane numbers as high as 80 are readily obtained and the leaded product, with an octane number of 94 represents a good base for aviation fuel. Motor fuel is obtained by high-pressure hydrogenation of coal at a cost comparable to the motor fuels synthesized by the Fischer-Tropsch process. For motor fuel production, the proper choice of process probably depends on the nature of the raw material and on conditions encountered locally. One of the big economic attractions of high-pressure hydrogenation is in the manufacture of heavy fuel oils and of certain products of potential value, e.g., of ash-free carbon for "coal dust engines." Certain other aspects of the process, for example the upgrading of heavy petroleum fractions, have already found industrial application in some installations of Standard Oil Company. (This process is apparently not in operation now, but has considerable potentialities in the preservation of petroleum resources.)

High-Pressure Hydrogenation Status

The possible need for fuels synthesis has had to be contemplated in the U. S. during recent years only and the industry is still in its infancy. Commercial high-pressure hydrogenation plants for upgrading various petroleum fractions have been operated at various times at Baton Rouge, La., Bayway, N. J., Port Arthur, Texas, Richmond, Calif., and Whiting, Ind.[2] A small coal hydrogenation "demonstration" plant—the country's first—was started on stream by the Bureau of Mines in the course of 1949.

Other countries have had to rely on synthetic liquid fuels for many years and their hydrogenation industry has attained respectable dimensions. Leading among these countries is Germany which started her twelfth high-pressure hydrogenation plant in 1943. Four of her plants in the Russian zone of occupation (Lutzkendorf, Wintershall, Magdeburg, and Bohlen) are reported to be operating at capacity today.[3] One plant in Western Germany (Scholven) has been bombed completely out of action while the fate of three others (Wesseling, Gelsenberg and Bothrop-Welheim) awaits final decision by the Allied governments. Two plants in Polish-occupied territory (Politz and Blechhammer) are reported to be in production once more.[5] The most modern European hydrogenation plant was constructed on Czechoslovakian soil at Most (Brux). This plant is now operating near capacity and covers the greater part of Czech motor fuel consumption.[6]

England operates an important hydrogenation plant at Billingham. Originally designed in 1935 for the hydrogenation of young coals at 250 atmospheres, it has for many years operated exclusively on the conversion of creosote oil. Another less well-known hydrogenation plant is operated at Heysham. In 1945, England produced 32.6 million gallons motor fuel by high-pressure hydrogenation.[7]

Japan erected a small (250 barrels per day) coal hydrogenation plant in 1936-1940. Until 1942, it was actually employed for the conversion of coal. Since that time it has been operated on kerosine and gas oil.

Two plants have been built in Italy (Bari and Leghorn). Spain has contracted for the erection of two lignite hydrogenation plants.[8]

Considerable interest has been shown by Russian industry in high-pressure hydrogenation plants. It is not known how far this work has progressed. Much of the reported Russian work has been concentrated on high-pressure methods for the extraction and treatment of shale oil.

Coal hydrogenation studies are also being pursued in Canada and in South Africa. Neither of these countries has serious industrial intentions along these lines at the present time. According to present indications, the projected South African synthetic oil industry will have to be based on the Fischer-Tropsch process because of the restricted suitability of local coals for the hydrogenation process.

Development of High-Pressure Hydrogenation

First reported work on high-pressure hydrogenation of carbonaceous matter is due to Bergius[9] who discovered in 1911 that coal can be liquefied by the action of hydrogen at pressures of about 3000 psi. and a temperature of about 900° F. Bergius' non-catalytic process was made the basis of a large-scale experimental plant erected at Rheinau in 1925.[10] The plant was capable of handling five tons of coal per day. The finely ground coal was mixed into a paste with a heavy coal tar fraction and was subjected to the action of hydrogen at 150 atmospheres, 890 pounds of oil, rich in cresols and phenols were obtained from one ton of coal, together with 420 pounds of gas and 700 pounds of residue.

Development of the Bergius non-catalytic process continued until 1930, after which time it yielded to the more successful catalytic processes which are capable of achieving better yields, higher-quality products, and greater throughput per unit reactor space.

Patent literature covers virtually the entire periodic system for use as hydrogenation catalysts. It is not the purpose of this presentation to engage in a discussion of the many types of catalysts which have been proposed or of the many different ways in which it was hoped to render their application most effective. Suffice it to say that early development tended to concentrate on the use of iron and nickel catalysts for primary liquefaction and that molybdenum compounds and tin compounds did not enter the picture until comparatively late in the 1920's. For a more complete discussion of the early development of primary liquid-phase catalysts, the reader is referred to an excellent study by Skinner.[11]

An intense research program for the development of sulfur-resistant catalysts was undertaken by I. G. Farbenindustrie in Germany and later also by Imperial Chemical Industries in England. By early 1925, a sulfur-resistant molybdenum catalyst had been developed, in the presence of which one volume of gasoline could be obtained from one volume of gen-

erator tar. This process was carried out in the laboratory over a fixed-bed catalyst with low throughput and very low partial pressure of the product.

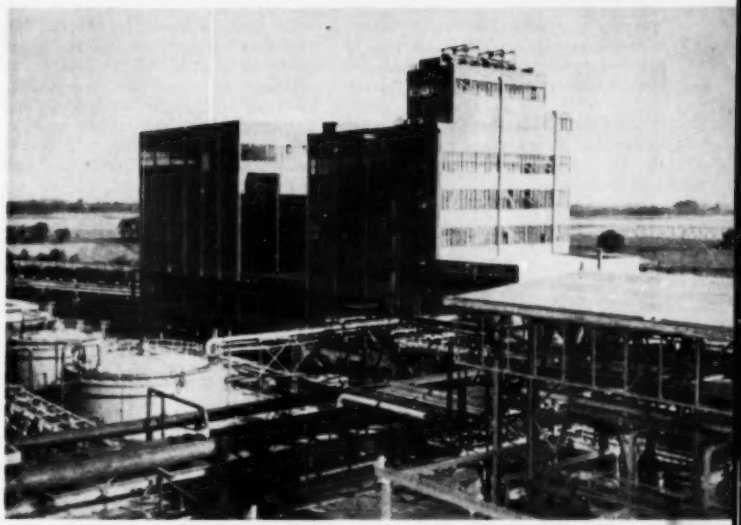
On a semi-commercial scale, it became necessary to operate with higher throughputs and greater partial pressures of the product. Under these conditions, the catalyst life was found to be unsatisfactorily short due to the deposition of high-molecular compounds on the catalyst surface. It was soon realized as a result of these findings that hydrogenation would have to be subdivided into two stages: Liquid phase and vapor phase. In the liquid phase the high-molecular compounds are converted primarily into middle oils of an end point of approximately 620° F., with the simultaneous formation of smaller amounts of gasoline and hydrocarbon gases. The liquid products (up to 620° F.) are then further treated in the vapor phase for conversion to high-grade gasoline.

In the early work at Leuna, a tungsten-magnesia catalyst (K2500) was used in the liquid phase. The catalyst was employed in a high concentration (25-30 percent) and the tar-middle oil mixture was recycled through the converter. The product of the reaction was continuously removed from the reactor system together with a small portion of the catalyst.[12]

This arrangement was unsuitable for the treatment of coal paste since ash and non-converted coal must be continuously removed from the reaction zone and cannot be separated from the catalyst withdrawn at the same time. Coal was therefore treated as a slurry and saturated with ammonium molybdate catalyst.

For ease of mechanical handling, the coal was introduced in the form of a paste with oils or tars rather than as a dried powder, a method to which some attention had been given in the early work. In 1929 it was shown that by lowering the throughput of the coal paste, an improvement in the product quality as well as in the conversion could be obtained in the presence of a quantity of catalyst (.02 percent MoO_3) small enough to be economically expendable. For brown coal a conversion of 95 percent could be obtained as compared to 70 percent for hydrogenation in the absence of a catalyst. Eventually, slurry operation was also employed in the hydrogenation of tars and oils to minimize the amount of recycling.

The years since 1929 have seen a steady development of catalytic conditions in primary liquefaction. Improvements which have achieved industrial significance will be discussed later. Probably the most striking fundamental developments in the liquid phase since the early commercial operations at 3700 psi. pressure are the advent of hydrogenation at 10,300 psi. for the liquefaction of geologically older coals, and the development of more suitable methods for processing the solid residue. Other important catalytic improvements are the development of tin and iron catalysts together with their modifiers and promoters.



Paste Preparation Area in a Hydrogenation Plant.

It has already been pointed out that the conversion of coal and heavy oils to gasoline has had to be subdivided into two stages of operation: The primary liquefaction carried out in the liquid phase and the refining and splitting carried out in the vapor phase. While the above evolution took place in the operation of the liquid phase, intensive work was also directed toward the development of a poison-resistant vapor-phase catalyst suitable for refining a large variety of different oils and converting the feed to a high grade of gasoline in good yield. The earliest installations employed a molybdenum oxide-magnesia-zinc oxide catalyst for this operation. In 1930, I. G. discovered a remarkably active and versatile hydrogenation and splitting catalyst in a specially prepared tungsten sulfide (WS_2). The gasoline produced by this catalyst in good yield was highly naphthenic and had a comparatively low knock rating (68-70). A great step forward toward the improvement of the product's octane number was taken with the development of diluted tungsten sulfide catalysts. A catalyst (6434) containing 10 percent WS_2 on Fuller's earth was developed which produces an aromatic high-octane gasoline of similar desirable boiling-point characteristics and in essentially the same yields as the gasoline produced over 5058. The diluted tungsten sulfide catalysts have, however, the drawback of being quite sensitive to nitrogen and oxygen content and of requiring a certain minimum hydrogen content in their feed stock. It became therefore the practice to precede the splitting operation over 6434 by a presaturation stage employing 5058 in which the oil achieved the required degree of hydrogenation and refining.

The IG process, operating at 4400 psi., was eventually also adopted by Imperial Chemical Industries and is believed to have been practiced at all but two hydrogenation plants. The lone exceptions are the demonstration plant of the U. S. Bureau of Mines at Louisiana, Mo., and the Ruhrol works at Bottrop-Welheim, Germany. The vapor phase at these two plants employs the Mo-Cr-Zn-S-on Fuller's earth catalyst developed by Ruhrol. This catalyst is operated at 10,300 psi. It has the characteristic of producing in a single stage—and in good yield—a gasoline which is the equivalent, from the point of view of engine performance, of gasoline produced in three separate stages by the IG process: 5058-6434-DHD (the last step in this operation sequence is a variant of hydroforming which is particularly suitable to the treatment of the cyclic products of high-pressure hydrogenation).

This, in broad outline, is the present

state of development of the high-pressure hydrogenation process, a process expected to play an important part in the future petroleum and synthetic fuels technology of the United States.

Outline of the Process

Figure 1 is a typical flow sheet of the IG process for the conversion of coal to aviation fuel.

The charge of the liquid phase is prepared by grinding and mixing the dried coal with a heavy pasting oil which is generally withdrawn from a) the heavy oil obtained by topping the cold catchpot bottoms of the liquid phase; b) the distilled oil from the low temperature carbonization (l.t.c.) of the residue and c) the centrifugation light oils. Some of the pasting oil may be procured from outside sources. The admixture of paste is necessary for reasons of mechanical conveying and to minimize the danger of settling out insoluble matter in the converters. For the latter reason, the introduction of diluent oil is also practiced for tars, petroleum residues, and other liquid raw materials.

Together with liquid phase catalyst, the charge is boosted to reaction pressure and fed through regenerative heat exchangers and a gas-fired preheater to the converters. At some point along the path (usually preceding the preheater), high-pressure hydrogen is admixed to the paste.

Primary liquefaction takes place in the converters where the paste residence time is about 1-2 hours. The molecular weight of the feed is stepped down and most of the raw material is converted to oil-soluble compounds. The reaction is highly exothermic and it is necessary to control the reaction temperature by injecting cold hydrogen at various points along the converters.

The effluent from the converters is passed to a "hot catchpot," operated just below reaction temperature. The liquid product from this vessel retains all the solid matter which must be disposed: ash introduced by the coal, the catalyst, and those components of the feed stock which have resisted conversion. After cooling and release of the pressure, this slurry—the "h.o.l.d." (heavy oil let down)—is mixed with a diluent oil (usually a heavy oil obtained by topping the liquid phase "cold catchpot" product). The mixture is centrifuged. The filtrate of this operation is recycled as pasting oil. The concentrate is subjected to a low-temperature carbonization in rotating kilns for the recovery of its volatile oil content.

The overhead product from the hot catchpot is cooled by passage through the regenerative heat exchangers and through water coolers and finally enters a high-pressure cold catchpot. The vapor phase leaving this vessel is oil-scrubbed for the recovery of light hydrocarbons. The scrubbed gas is boosted to reaction pressure and recycled to the converters.

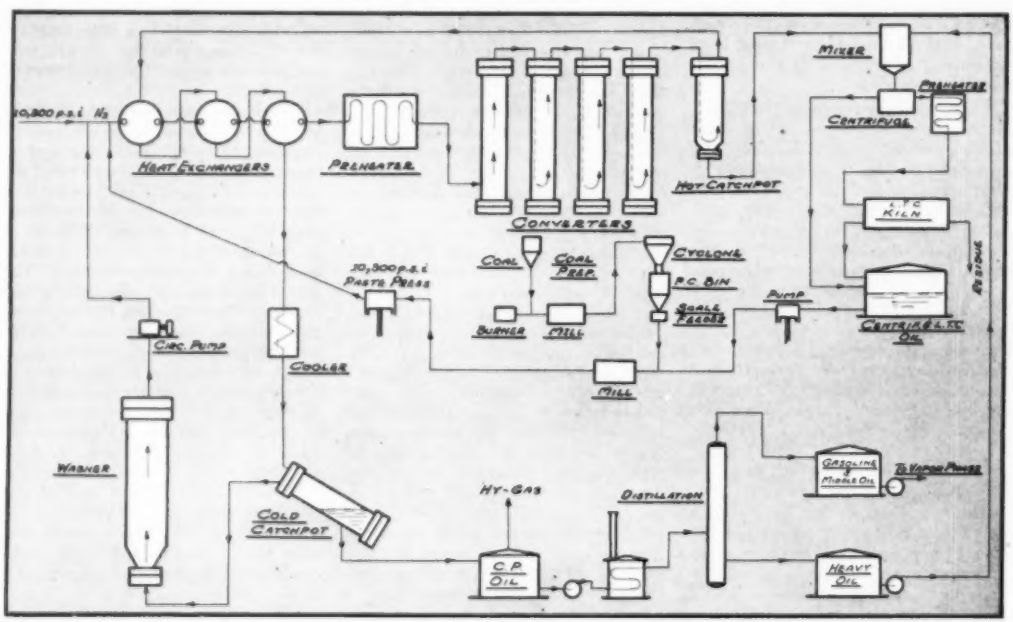
The liquid product of the cold catchpot is released to atmospheric pressure in two or three successive stages. Gas released in the first stage is lean in hydrocarbons and consists primarily of hydrogen which is recompressed, oil-scrubbed, and recycled to the converters. The gas released in the second (and third) stage is rich in hydrocarbons which can be separated in a low-temperature fractionating plant.

The liquid leaving the final pressure reducing stage goes to the liquid-phase distillation (A-distillation) where separation is effected between the heavy oil (boiling above 615-660° F.) and middle oil. The bottoms of the distillation are recycled as pasting oil. The overhead fractions are sent to the vapor phase, Figure 2.

A-middle oil is raised to reaction pressure and introduced into the vapor phase via heat interchangers and a preheater furnace in a manner not unlike that already described for the liquid phase. Sufficient high-pressure hydrogen is added preceding the heat exchangers to assure complete volatilization of the oil.

In order to maintain the activity of the tungsten sulfide catalysts employed in the vapor phase of the IG and ICI processes, it is necessary to dope the feed with sulfur. This may be done by the addition of elemental sulfur or, preferably, of hydrogen sulfide which

Figure 1. Catalytic Coal Hydrogenation (Liquid Phase)



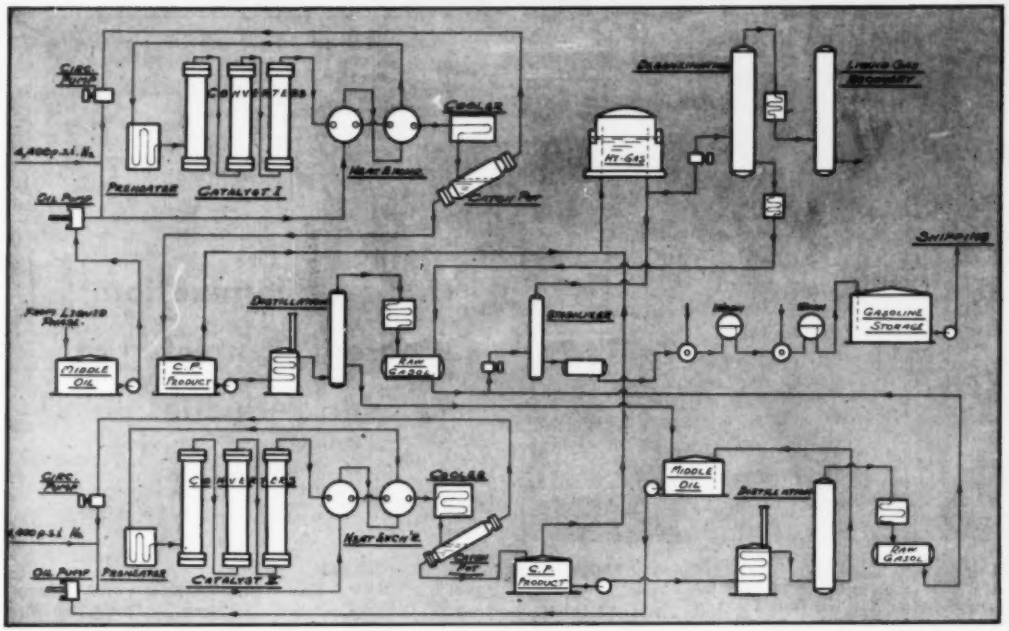


Figure 2. Catalytic Coal Hydrogenation (Vapor Phase)

can be removed from the products and recycled.

For reasons stated above, the vapor phase hydrogenation over tungsten sulfide catalysts takes place in two successive stages: saturation over WS_2 and splitting over 10 percent WS_2 on Fuller's earth. This mode of operation permits the use of lower temperatures than any other known effective catalytic condition. The advantage of low-temperature operation is the reduction of gas formation to a minimum. By proper temperature control in the vapor phase, the amount of methane and ethane formed at this stage can be maintained at a very low level with consequent improvement in gasoline yield and reduction of hydrogen consumption.

The hydrogenation reactions occurring in the vapor phase are highly exothermic. Adequate operating control will not admit a temperature gradient exceeding 35° F. All commercial installations operated to date solved the problem of temperature control by arranging the catalyst in several separate beds inside the converter and injecting cold hydrogen between the various layers.

The product leaving the converters passes through heat exchangers in which it gives up its sensible and latent heat to the incoming charge. Finally, the product is water-cooled and its two phases are separated in a high-pressure cold catchpot. The gas may be recycled directly (it contains less hydrocarbons than the gas from the cold catchpot of the liquid phase) or it may be subjected to an intermediate oil and water wash. The pressure over the liquid product is reduced in three successive stages. Again, the first letdown to 370 psi. results in the evolution of a lean gas which may be scrubbed and recycled or else may be burned. The second and third pressure reduction stages yield comparatively rich gases of increasing molecular weight. They also release H_2S which is scrubbed from the gases and recycled.

The liquid product from the saturation stage is subjected to an acid wash followed by a caustic wash (for the removal of tar bases, ammonia, and acids) and is finally scrubbed with water.

Operation in the saturation stage at Billingham, England, is so carefully controlled that very little gasoline and L. P. gases are formed. It is therefore possible to pass the entire liquid product directly to the splitting stage for gasoline production from a refined and naphthenic middle oil feed.[13] Saturation stage temperature in German hydrogenation works was less carefully controlled and the feed stock to this stage contained liquid-phase gasoline. As a result the liquid product of the saturation operation contained appreciable portions of gasoline which could not be subjected to the splitting stage advantageously. In these plants, it was therefore necessary to introduce an intermediate "B"-distillation. A gasoline of only moderately high octane rating was taken overhead. The still bottoms were subjected to splitting.

The operation of the splitting stage is essentially similar to the saturation stage. The crude product is stored in the absence of air to prevent the oxidation of hydrogen sulfide to elemental sulfur. From the intermediate storage tanks the oil passes to the "C"-distillation plant in which the gasoline is separated from the middle oil. The latter is recycled. The gasoline is washed and stabilized by the methods commonly practiced in refineries.

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(End of Part I. Part II will appear in an early issue.)

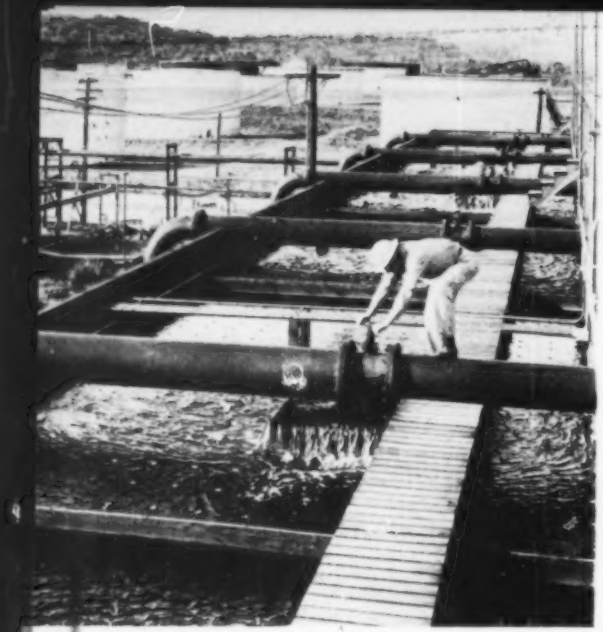


Figure 1. Thirty-eight feet above ground valves are opened to the lake-like upper level of a new water-cooling tower at Gulf Oil Corporation's modernized refinery at Cincinnati. Heated water from the refining process, circulated at 20,000 gallons per minute, is cooled here.

Gulf's Modernization Program Completed at Its Ohio Refineries

THE two Ohio refineries of Gulf Refining Company, at Toledo and at Cincinnati, were put in full operation in late October upon completion of an 18-month program of expansion and modernization.

Sixteen new refining structures, buildings and plant extensions have been erected at each refinery, as well as additional tankage which increases petroleum storage capacity by approximately 1.2 million barrels.

The production capacity of the Toledo refinery has been increased from 24,000 to 40,000 barrels of petroleum products a day. At Cincinnati the daily output can be increased from 23,809 to 27,809 barrels.

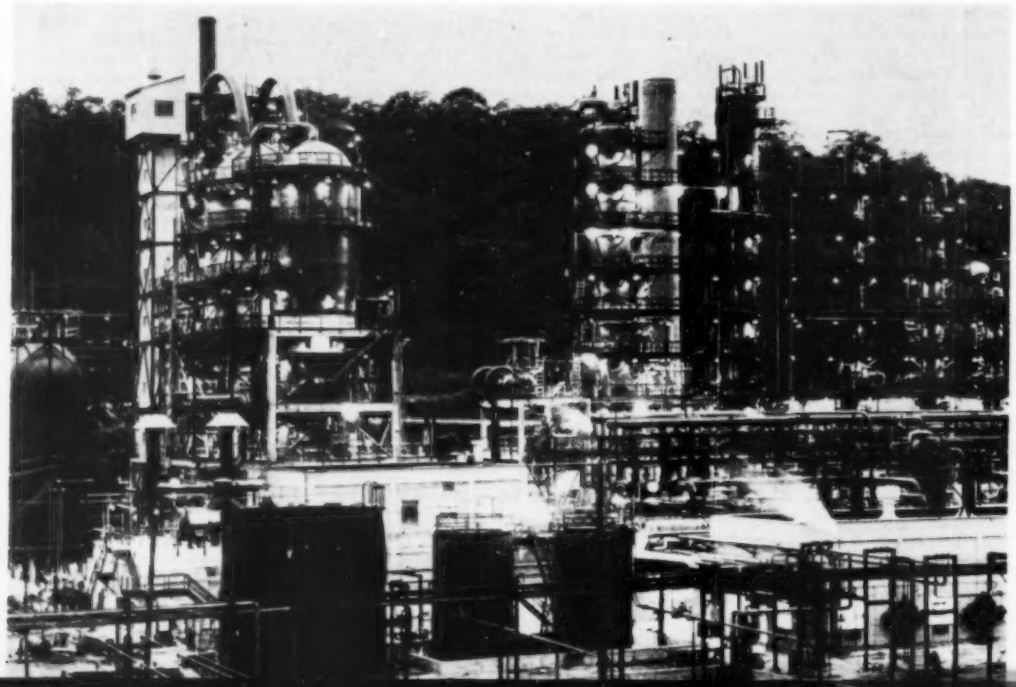
Three large new tanks and smaller propane storage units add to the storage capacity for propane and other LPD.

The larger of the two expansions, costing $20 million was carried out at the Toledo refinery, $15 million having been spent at the Cincinnati plant. **(See Figure 2, below.)** Heart of the new installations at both plants is a giant fluid catalytic refining unit.

New flare facilities which consume excess refinery gases in event of an interruption of operations and new smokeless boilers prevent air pollution. A new water cleansing system at Toledo, and an enclosed recirculation system at Cincinnati, guard against stream contamination. **(See Figure 1, above left.)**

Gasoline of high octane and fuel oil

Figure 2. The Heart of Gulf's Modernized Refinery at Cincinnati. Left to right are seen towers where catalyst is stored; the cracking unit; and fractionating towers.



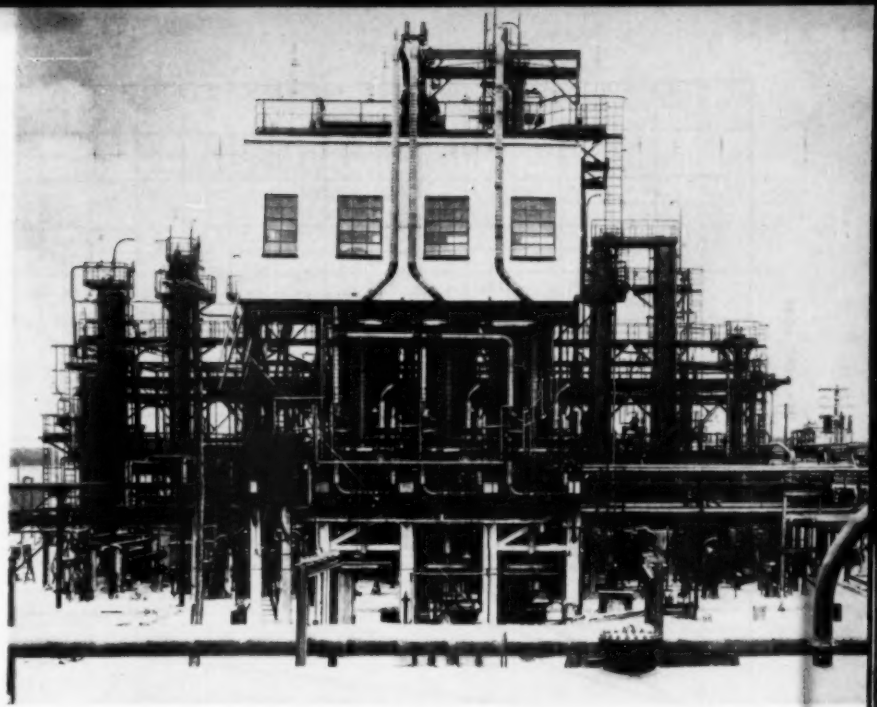


Figure 3. New polymerization completed by Gulf at Toledo.

are produced at both plants in the new fluid catalytic cracking units.

More than 500 gauges and instruments are located in central control rooms of each unit guide. Petroleum stock is supplied for the process by a new atmospheric-vacuum crude oil unit at Toledo and modernized topping and cracking crude oil installations at Cincinnati.

At both plants new polymerization units have been erected. **(Figure 3 right.)** Additional copper sweetening units of 378,000 gallons capacity each were included.

New storage tanks increase the combined petroleum storage capacity of the two refineries to a total of approximately 4.2 million barrels.

Two new smokeless boilers, with capacities up to 75,000 pounds of steam per hour each, approximately double the steam capacity of each plant. Chemical water-treating facilities have been nearly doubled.

A separator removes contaminants before any water is returned to the river at Toledo. At Cincinnati a new induced draft water tower, 38 feet high by 145 feet by 63 feet, built of California redwood, cools heated water so it may be continuously reused. It circulates 20,000 gpm. through the units and the tower.

New maintenance buildings at each plant permit all but major alterations and repairs to be carried out by refinery crews. Separate instrument shops also were included.

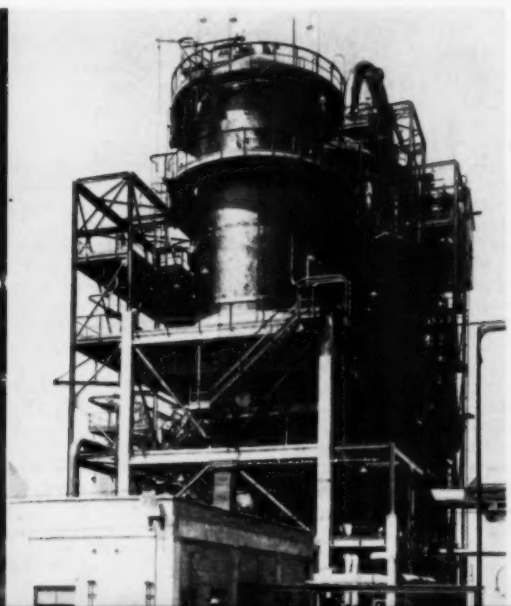
Continuous scientific control of production quality is provided by new testing laboratories in both cities. Each of these contain gasoline octane-testing machines, automatic gas analyzers, catalyst testing and distillation devices, and other chemical and physical testing equipment. **(See Figure 4, below.)**

New electrical sub-stations have been added, three transformer banks having been added at Cincinnati. The employe locker rooms have been doubled in size and additional storage and office space has been built. Foam system lines, roads, railroads, and loading racks have been extended substantially.

With their expanded facilities, the Toledo plant now occupies 200 acres on the Maumee River and the Cincinnati plant covers 175 acres on the Great Miami River.

Figure 4. Octane testing machine, Gulf Laboratory at Toledo.

Figure 5. Closeup of a Cat Cracker, Gulf Plant at Toledo.



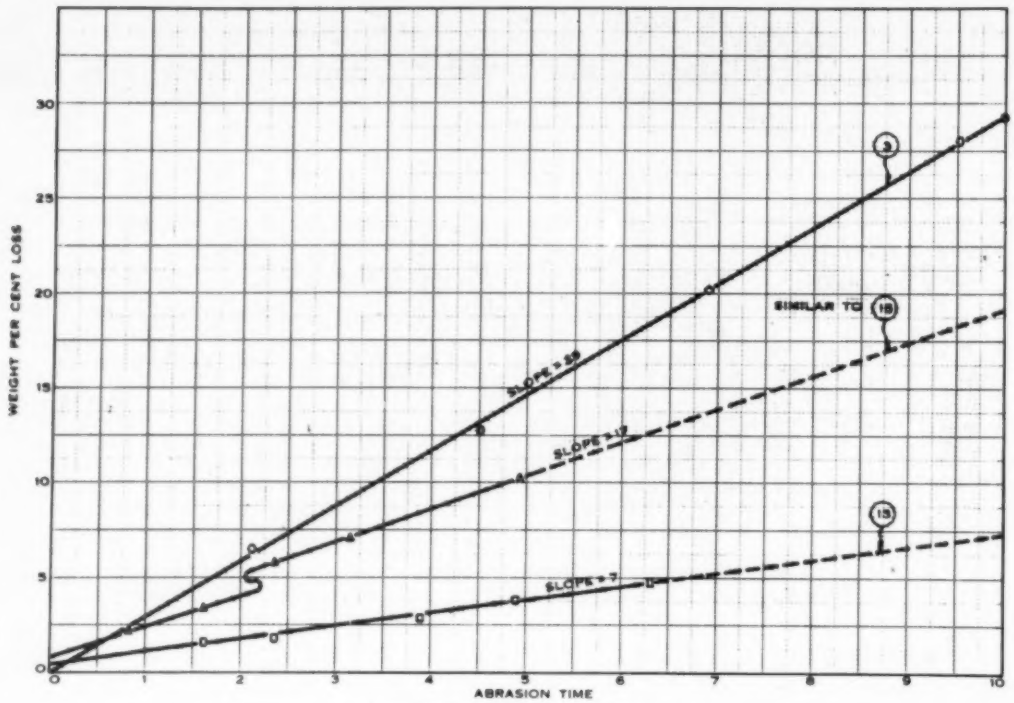


Figure 1. Typical Pebble Abrasion Curves.

Development of Test Methods For Heat-Exchange Pebbles

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***DISCUSSED** in the accompanying article is the experimental procedure for determining the relative resistance of ceramic pebbles (as a heat-exchange medium) to abrasion and to severe, cyclic, thermal and mechanical shock, typical curves being presented from the data collected. As a result of these experiments, originally described at the Refractories Division meeting, American Ceramic Society, Cincinnati, last April, a choice may be made of suitable pebbles for use as heat carriers. One pebble in particular was found to include the most desirable characteristics in the best combination.*

THE potentialities of ceramic pebbles, or pellets, as a heat-exchange medium at temperatures well above the limits of usefulness of steel equipment are becoming important industrially. Temperatures close to the useful limits of super-duty and high-alumina refractory brickwork may be reached and exceeded. The use of moving refractory pebbles as a heat carrier imposes severe requirements on the ceramic body employed. Severe heating and cooling shocks are frequently and rapidly applied. Resistance to thermal spalling and to mechanical impact is required above that for nearly any other application under which refractories may be used. Intensely abrasive conditions will be present; wear may occur against both metallic and refractory surfaces. High bearing loads may be encountered depending upon the size of the vessels used and upon the materials from which the refractory pellets are made. The pebbles must be relatively inert to chemical reactions and must withstand oxidizing, reducing, and corrosive atmospheres.

Since the ceramic pellets will be subjected to such rigorous treatment, new materials and methods of manufacture were needed to form non-plastic materials into balls capable of withstanding such conditions of use. In addition, development of new test methods was required so that various pebbles could be evaluated and compared for resistance to this severe treatment.

Experimental Procedure

The time and expense of testing ton-lots of pebbles was prohibitive; methods and apparatus were therefore devised that would permit the evaluation of small quantities of pellets under accelerated test conditions. Small-scale apparatus simulating the commercial heat-exchange equipment was devel-

oped in which a representative sample of a few of the test pellets was continuously subjected to cyclic thermal and mechanical shock. Heating rates of the order of over 1500° F. per minute and cooling rates of over 3000° F. per minute were applied many times an hour. The number of cycles of this treatment required to break 50 percent of the pebbles was taken as the "half-life." Results were plotted as the percent pebbles unbroken versus cycles of shock.

As an additional measurement of resistance to thermal shock, pebble samples were heated in an electric laboratory-furnace then quenched in boiling water and residual crushing strength determined. Comparative results were plotted. In order to measure the crushing strength of the pebbles, apparatus was constructed by which the force required to break a pebble could be measured. A representative number of pebbles was thus broken and the strength recorded. Generally, the pebbles failed by vertical shear and separated into three or four, more or less symmetrical parts. In many cases, conchoidal fractures were observed even though little, if any, glass was present.

TABLE 1
Relative Crushing Strength of Typical Pebbles

Pebble No.	(1) Avg. Relative Strength of "Groups" of Pebbles*	(2) Deviation From Average of All "Groups"	(3) Percent Deviation From Avg. of All "Groups"	(4) Maximum Deviation of Individual Pebbles* Relative	(4) Percent
3	1st Group 0.491	−0.013	2.6	+0.439	87.
	2nd Group 0.518	+0.014	2.8	+0.229	45.
	3rd Group 0.574	+0.070	13.9	+0.489	97.
	4th Group 0.519	+0.015	3.0	+0.228	45.
	5th Group 0.420	−0.084	16.7	−0.285	57.
	Average 0.504	0.039	Avg. 7.8	Avg. 0.334	Avg. 66.
12	1st Group 0.915	−0.085	8.5	+0.276	28.
	2nd Group 1.166	+0.166	16.6	+0.702	70.
	3rd Group 0.945	−0.055	6.5	+0.402	41.
	4th Group 0.907	−0.093	9.3	+0.344	34.
	5th Group 1.074	+0.074	7.4	+0.600	60.
	Average 1.000	0.095	Avg. 9.5	Avg. 0.465	Avg. 47.
13	1st Group 0.466	−0.020	4.1	−0.208	43.
	2nd Group 0.489	+0.003	0.6	−0.183	38.
	3rd Group 0.491	+0.005	1.0	−0.183	38.
	4th Group 0.504	+0.018	3.7	+0.206	63.
	5th Group 0.484	−0.002	0.4	−0.135	28.
	Average 0.486	0.010	Avg. 2.0	Avg. 0.203	Avg. 42.

* Compared with the average of all "groups" of pebble number 12 which value was taken as 1.000.

TABLE 2
Comparative Test Data

Pebble No. (1)	Manufacturer (2)	Half-Life in Cycles for 50% Unbroken (3)	Relative Rate of Abrasion‡ (4)	Relative Crushing Strength‡ (5)
1	A	20*	5.5†	1.09
2	B	79*	5.5†	0.98
2A	D	93*	2.8†	0.37
3	A	10	4.8	0.73
4	A	36	6.0	0.23
5	A	50	5.5	0.41
6	A	60	4.7	0.97
7	B	80	3.3†	1.01
8	A	80	4.0	0.64
9	A	91	5.0	0.84
10	B	100	1.7†	0.73
10A	C	130	1.0	0.80
11	B	138	3.3†	0.72
11A	B	140	1.8	1.42
12	B	170	3.3	1.45
13	C	375	1.3	0.70
13A	B	400	0.3	1.98
14	B	505	3.2†	0.72
15	D	590	1.0	1.00

* These are not strictly comparable with the remaining data in this column, for less severe conditions of test were used. The values for pebbles 1, 2 and 2A are the percent unbroken after 500 cycles.
† Estimated from similar pebbles.
‡ Compared with pebble 15.

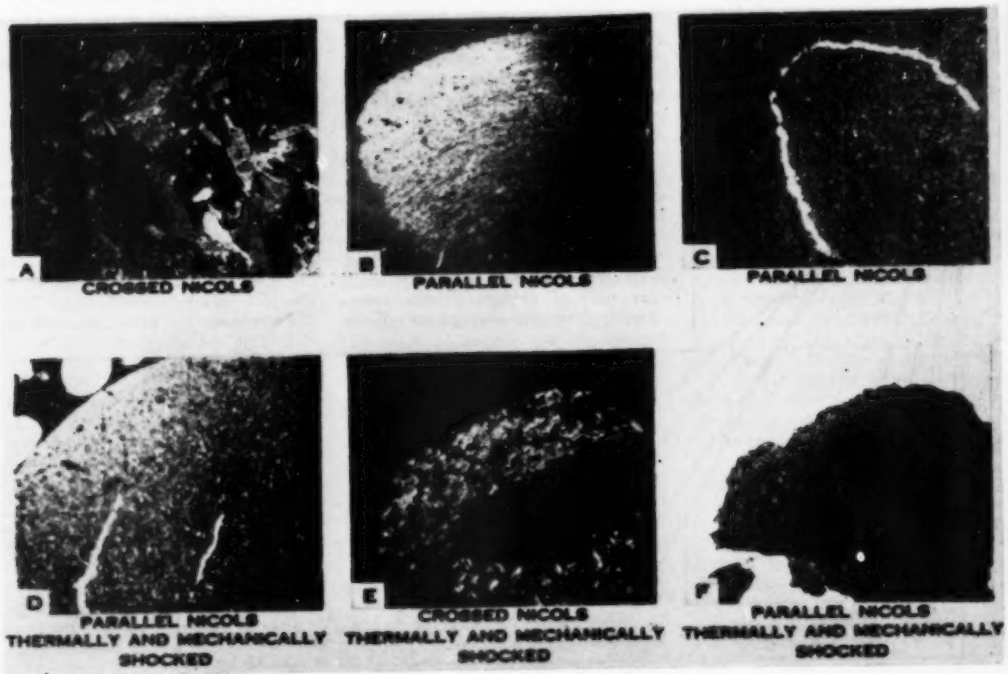

Figure 2. Photomicrographs of Typical Pellets.

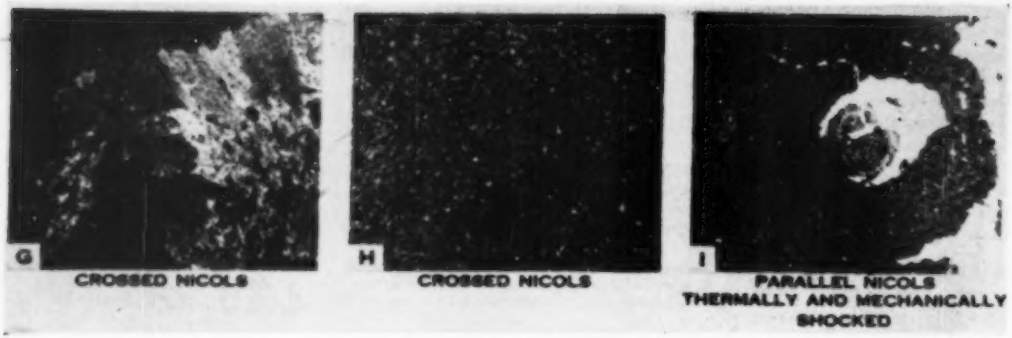

Figure 3. Photomicrographs of Typical Pellets.

For the application desired, high resistance of the pebbles to abrasion was recognized as a property of paramount importance. In order to determine relative degree of wear, apparatus was built which permitted investigation of rates of abrasion under closely controlled conditions in short periods of time and with small pebble samples. Results were reproducible to ±4 percent.

Discussion of Experimental Results

About 246 pebble samples of various kinds and types obtained from a number of different manufacturers were tested involving some 350 runs in the several pieces of apparatus. Generally, the information reported herein is confined broadly to the same pebble type.

In Table 1 are listed crushing-strength data from three representative pebbles. To obtain a reasonably correct value for any one type of pebble, a number of pebbles were tested and the average for the group taken as the crushing strength. A check of the reproducibility was made by running five "groups" of the same pebble in a number of cases. The relative values given in Table 1 are the ratios between the crushing strengths of the particular "group" to that of the average of all "groups" for pebble No. 12 (listed in Table 2).

In Table 2, comparative test data are listed for a series of pebbles arranged in the order of increasing half-life. The relative rates of abrasion are given as compared with pebble No. 15 which was the longest-lived pebble in resistance to thermal and mechanical shock. The data in the column for crushing strength are also relative and are the ratio of the strengths of the pebbles listed to that for pebble No. 15.

In the typical crushing-strength data illustrated in Table 1 for three rather similar pebbles, pebble No. 13 was the best of the three and was considered to be fairly representative of the more consistent samples. The arithmetical averages in column (1) of the small "groups" of pebbles deviate rather greatly from the average for all the "groups" of a particular pebble. This deviation is indicative of the degree of variation of that sample group from other sample groups and is a measure of the structural inhomogenities of individual pebbles within the sample. Although the relative deviations in the small groups were large, the deviations expressed in percentage values were considered reasonable in value. These were found to vary up to 20 percent for the poorer pebbles and up to 5 percent for the better pebbles. In every small sample group of pebbles, however, wide fluctuations in crushing strength of individual pebbles were noted even for pebble No. 13. These undesirable variations tended to be averaged out, as the figures in column (3) show, when larger quantities of pebbles were used for the samples. Because of the fact that the pellets were not true spheres, minor variations in the crushing strengths were expected. The presence of fissures within the pellets, however, caused extreme variations in crushing strength from pebble to pebble. More consistent crushing data were obtained as more care was exercised in pebble manufacture to eliminate cracks, stratification, laminar structure, size variations, and dif-

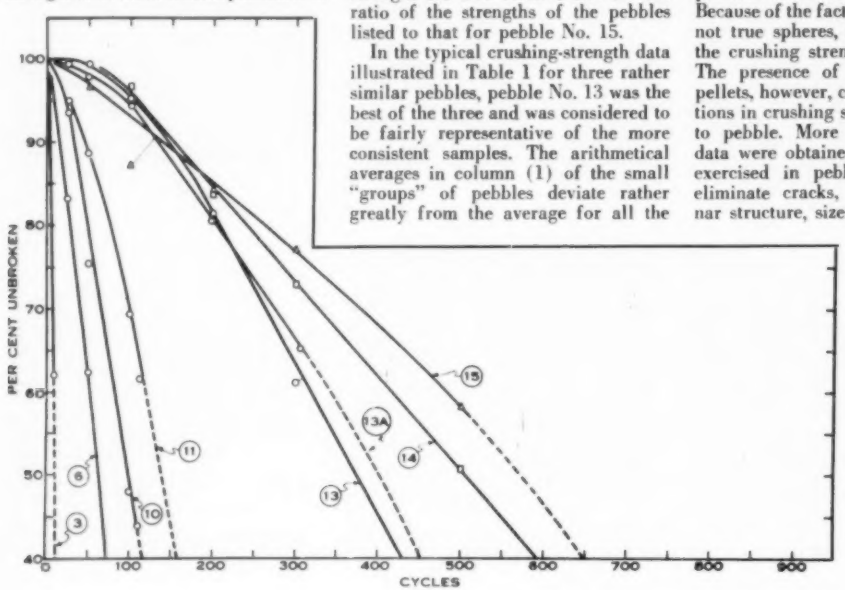

Figure 4. Improvement in Pebble Life by Close Manufacturing Control.

ferences in degree of spherality. Pebble No. 13 may be considered as an example of the result of these developments.

The very large divergencies among the different types of pebbles in their resistance to thermal and mechanical shock and to abrasion are illustrated in Table 2. The half-life of pebble No. 15 is nearly 60 times greater than that for pebble No. 3. The fact that the former also exhibited high abrasion resistance and that it had a high crushing strength made the pellet of considerable interest. The abrasion resistance of the several pellets listed varied by over 18 times that of the minimum. The rate of abrasion for pebble No. 13A was found to be less than one-third of that for any other pebble. The high abrasion resistance of this particular pebble together with its high crushing strength and long "half-life" made it unique and outstanding.

The differences in average crushing strengths were not as pronounced as those for fatigue resistance. Although the crushing strengths of pebbles No. 1, 7, and 15 were about equal, the resistance to fatigue and to abrasion were markedly different being successively greater. A close correlation was not found between crushing strength and the other two illustrated properties. Generally a high crushing strength was associated with a low rate of abrasion but there were a number of exceptions to this broad rule. No apparent correlation existed between an increase in resistance to shock and a decrease in the rate of abrasion. A number of the "longer-lived" pebbles, as shown by the last group of pebbles in Table 2, abraded quite rapidly and the rate of abrasion varied quite considerably.

Typical abrasion curves are illustrated in Figure 1. Usually the abrasion of the sample proceeded as a straight-line function. The rate of abrasion was determined from the slope of the curves. At times, an abnormally high increase in loss of weight during the course of a run could be accounted for by the inadvertant loss of a pebble or two during weighing. Thus, sets of the plotted points could easily be connected with parallel lines all with the same slope as illustrated by the curve for the pebble similar to No. 15 on Figure 1.

Figures 2 and 3 are illustrations of the internal structure of typical pebbles. Microscopic thin-sections of selected pebbles were made by the usual techniques and were photographed through a petrographic microscope with polarized light. In some cases, as indicated, the light passing through the specimen and refracted by it was repolarized into vibrations in one plane. This was accomplished by insertion of the upper or analyzing nicol (a second polarizing prism) at which time the nicols were "crossed."

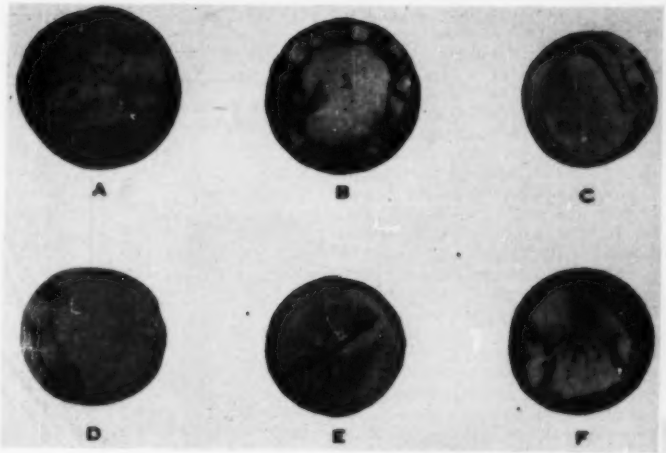

Figure 5. Illustrations of Fractures in Pebbles Resulting from Cyclic Shock.

Most remarkable in the photomicrographs is the large granular formation of pebbles *A* and *G*. Individual crystals in the former may be observed up to 1.5 mm in length; other crystals in this specimen were observed 3.5 mm in length. In the illustration for pebble *G* a hetergenous structure may be observed; the grains vary in size from cryptocrystalline to laths 2 mm. in length, oriented for the most part, parallel to the surface of the pellet. A similar pebble is displayed in Figures 2E and 2F. The dark area at the center in these illustrations was caused by an overlap of two portions of the thin section. The intermediate grain size of this pellet is noted, one-tenth the size of those in *A* and *G*. When the nicols of the microscope were parallel, a stratification of material parallel with the surface of the pellet is observed. A crack as a result of rapid cooling of the pellet during test can be seen entering the pebble from the number four quadrant of the photomicrograph. In the remaining illustrations, dense pebbles of fine particles are pictured. The previously mentioned layering or stratification of grains is observed in pebbles *B* and *I* where the pebble structure appears as a series of concentric shells. The results of thermal shock can be seen in *I*. Not only did considerable fracturing of the pebble occur, but also the nodule-like center fell or broke from the thin section. Grains were also pulled from the section during grinding. In pebbles *C* and *D* no concentric banding was found but large fissures were present, some of which were extensive in length. Most of these were found to parallel the surface of the pellet. Fine hairline cracks may be observed in Figure 2D beginning at the outer edge and extending perpendicularly from the surface. These were a result of the high cooling shock imposed. The finely textured structure of the pebble in Figure 3H is of interest. The fissures present in pebble *C* were found to be absent in *H*. The center of the latter, however, was lost during grinding of the thin section.

The results from the cyclic-fatigue tests of several representative pebbles are plotted in Figure 4; these data were taken at frequent intervals during the course of a run. The extremely long life of pebbles No. 13, No. 13A, No. 14 and No. 15 is quite impressive. Differentiation among the remaining four pebbles would be difficult from this graph because of their very high breakage rate. Changes to the equipment, however, permitted extension of the plotted abscissa to a greater length so that the curves could be spread for a more nearly accurate appraisal of the pebbles. As a general rule, most of the curves were similar in configuration, dependent on the rate of pebble breakage. Once fractures developed and breakage began the pebbles failed at an accelerating rate as shown by the increasing slope of the curves.

A number of different types of fractures were observed to occur in various pebbles during the course of the cyclic-shock treatment. Several of these are illustrated in Figure 5. The cracks in each of the pictured pebble sections were accentuated by light applications of an inking pen to the lines of the fracture; the ink quickly entered the pebble through these lines of separation and readily outlined the breaks from one

side of the pebble to the other side. In certain cases a very limited number of cracks were disclosed. In short-lived pebbles, the number of breaks was extreme as shown by Figure 5A. The underside of this pellet was literally honeycombed with fractures. When the cracks entered the pebble perpendicularly to the surface, as pictured by Figure 5D in which the pebble sheared in half into nearly two hemispheres, the fracture was noted to be caused essentially by the cooling cycle.[1] A fracture having an angle of entry of 45 degrees to the tangent to the surface indicated a heating crack as illustrated by Figure 5F. The "orange-peel" separations show by *B* and *C* were not uncommon. In many cases, the condition was so extreme that large circumferential voids between successive layers were observed. In other cases, the whole nodular center, as previously shown, dropped from the pebbles when broken.

During the course of thermal-shock treatment, a precipitous loss of strength was observed in all pebbles. Illustrations of these results are given in Figures 6 and 7. The ordinate in Figure 6 is the ratio of the strength of the pebble to the original strength of pebble No. 15. In every case, except for pebble No. 13A, the major loss of strength occurred during only a few cycles of shock. Even though pebble No. 12 had a large initial strength the percentage loss in 25 cycles of shock was great and it rapidly became weaker than pebble No. 15. This property was a contributing factor to the shorter life of pebble No. 12 as compared with No. 15.

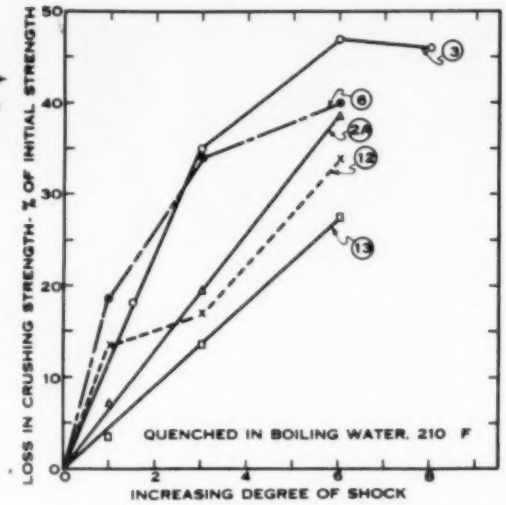

Figure 7. Comparative Quench Tests.

Figure 7 illustrates some of the data obtained from quenches of pebbles in boiling water. Here the abscissa represents the increasing severity or degree of shock above the temperature of the quench medium. Even a very moderate shock caused a significant loss of strength. As would be expected, an increase in the degree of shock caused a corresponding increase in the decline of residual pebble strength.

Pebbles No. 1, 3, 6 and 13A are representative of those in large-scale production. The others for the most part were made in experimental quantities and were unsatisfactory or were unavailable for use for one reason or another. In many cases when production of semi-commercial quantities was attempted, unacceptable test results were obtained. Based on the test data, pebble No. 13A was deduced to possess by far the best all-around properties. Its strength and resistance to abrasion were superior as was its resistance to fatigue during mechanical and thermal shock. Although a few other pebbles surpassed it in this latter connection, they all were inferior in some other necessary property. In pebble No. 13A, the most desirable characteristics were included in the best combination.

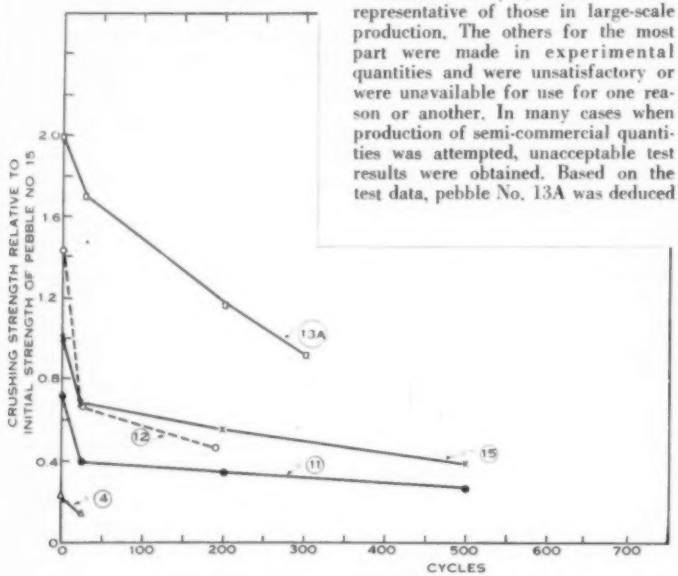

Figure 6. Effect of Cyclic Shock on Pebble Strength.

Conclusions

From the extensive data collected on the resistance of a large number of pebbles to severe thermal and mechanical shock and to abrasion, a choice of suitable pebbles for use as heat carriers may be made. Actual selection depends upon the particular process in which the pebble is to be used since the severity of conditions and their relative importance must be examined. Possible compromises in certain properties of minor interest may be considered. Several pebbles have been developed which possess in high degree the properties desired. One pebble in particular was found to combine these properties. The method of manufacture in pebble production was found to be of great importance. Satisfactory correlation was found among the empirical test results and the petrographic data. Correlations are being developed on pebbles in actual use.

REFERENCE

[1] F. H. Norton, Refractories, p. 163, McGraw-Hill, New York, 1942. 798 pp.

ACKNOWLEDGMENT

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Recent Developments—

Measurement of Metal Thickness From One Side

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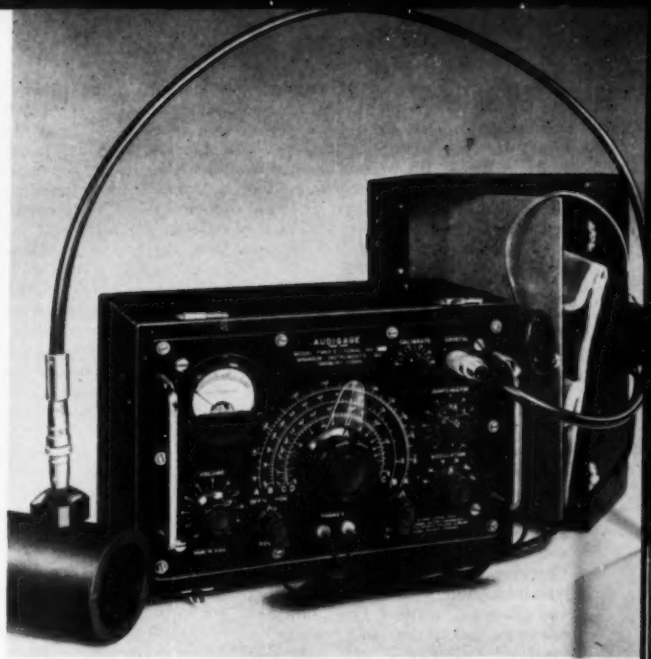

Figure 1. Close-Up View of the Instrument Used in Measurement of Metal Thickness from One Side.

ONE popular electronic instrument used for measuring metal wall thickness from one side, a method which has greatly reduced the cost of inspection of steel pipe, pressure vessels, etc., in refineries and chemical plants, has recently been re-designed in accordance with operating experience gained during the past two years.

This instrument, shown in Figure 1, operates on the ultrasonic (high-frequency sound wave) resonance principle, and measures thickness by determining the frequency at which resonance of the ultrasonic waves occur.[1] The instrument has a range of 1/16 inch to 12 inches of steel, weighs 23 pounds, and has a self-contained dry cell power supply. It will also measure the thickness of other materials with high elastic constants, such as brass, aluminum, glass, etc.

This instrument was first offered on the market in the fall of 1946, and since that time approximately 200 instruments have been placed in use throughout industry, in plants that represent approximately 60 percent of the refining capacity in the United States as well as in numerous chemical and steel plants. The original design established the fact that there was a definite need for this type of instrument throughout industry.[2] Several difficulties were encountered in operating this first instrument under field conditions, however, and it was therefore re-designed on the basis of information obtained through actual plant use.

The new model can withstand rough usage, incorporates the best available components, and is not seriously affected by high humidity. Suggestions received from users, such as longer cable length and greater thickness range, have been incorporated. Sensitivity and the ability to measure material with very rough, corroded surfaces has been increased. A visual indication of thickness has been added, to facilitate measurement in noisy locations.

***FOR THE PAST FEW** years there has been a considerable increase in the use of electronic instruments for measuring metal wall thickness from one side. Such instruments have been designed primarily for thickness determination of refinery and chemical plant equipment, such as steel pipes, tanks, pressure vessels, and other structures that are often accessible from only one side, due to physical limitations of the structure, or to operation conditions. Older methods of inspection, such as drilling a hole, calipering the wall thickness, and re-welding, have been replaced to a large extent, especially in the larger refineries. Use of these instruments greatly reduces the cost of inspection, and often enables inspections to be made at points which could otherwise not be measured because of safety limitations, danger of increased corrosion in the weld area, etc.*

Applications

This instrument is used extensively in determining the extent of corrosion in refinery equipment, and has been used for location of defects such as hydrogen blisters or laminations.[3] Many plants have set up routine periodic inspections of their equipment, and are obtaining complete data concerning corrosion rates and over-all condition of plant equipment. Several large refineries in the Southwest have two of these instruments available for peak inspection periods such as unit shut-downs. The use of these instruments often results in considerable savings in the time required for plant or unit "shut-downs."

A survey is made prior to shut-down, to determine what equipment should be replaced, what equipment requires further inspection, and what equipment need not be disturbed. Such information expedites inspection and maintenance procedure during the shut-down, and saves the time which would have otherwise been consumed in inspection of equipment in good condition. Elimination of even a few hours of "down" time often justifies the cost of the instrument, dependent

of course upon operating conditions and the size of the plant. Cases have been known where down time worth $1000 per hour has been cut as much as 24 hours. At the present time, this type of inspection is limited to equipment operating below 200° F. New detector heads satisfactory for temperatures up to 500° F. are at the development stage.

Such instruments facilitate the complete and rapid survey of fractionating towers and other large insulated pressure vessels which have been taken out of service for inspection. These vessels are usually inspected from the inside and it is therefore not necessary to cut and replace exterior insulation. In some cases, doubtful areas can be located visually and rapid thickness measurements taken, in other cases erosion and corrosion occur over wide areas which cannot be located visually, and an over-all survey must be made. Checking of more than a few points was impossible with the old "drilling and plugging" method. One plant, for example, makes complete surveys of insulated "digestors" and finds that about 200 thickness readings in each vessel can be made at a cost approximately equal to that previously required to drill, caliper, and re-weld four test holes.

The instrument is often used on piping and on filled storage vessels, such as gasoline storage, butane tanks, etc. Accuracy is not affected by the contents of the pipe or vessel, nor by deposits such as coke or scale. Signal strength will be reduced when such conditions are encountered, and a skilled operator can often determine liquid levels or the presence of carbon. On pipe less than 6 inches in diameter, performance can be improved by the use of curved crystal detector heads cut to fit the contour of the pipe.

Theory of Operation

The gauge consists essentially of a high-frequency electronic oscillator, a quartz crystal "transducer" to convert electrical energy from the oscillator into mechanical pressure waves, and a means of detecting the frequency at which a resonance condition is set up in the material. The standard instrument has a frequency range of from .65 megacycles to 2.00 megacycles. (One megacycle is equal to a million cycles per second.)

The pressure waves are beamed into the material from one surface by the crystal transducer, travel through the material at a constant velocity, are reflected at the opposite surface, and travel back to the transducer. Since velocity through a given material is constant, the time required for a wave to make the round trip is a function of the distance traversed, which in this case is equal to twice the thickness. Therefore, if a means of measuring time is available, the thickness can be determined. Since the time interval between successive recurrences of an oscillating frequency is a measure of time, the rate of oscillation can thus be utilized as a timing device. If frequency is adjusted to a point where a wave is propagated from the transducer at exactly the same instant that the previous reflected wave has arrived back, then the so-called resonance condition is set up, and the time interval between recurring cycles is directly proportional to thickness. This resonance condition is detected by the instrument because of increased power required to drive the oscillator at resonance, and therefore the frequency at which it occurs can be utilized to determine thickness.

The following equations illustrate mathematically the conditions which are set up.

It can be seen that distance traversed by the wave is equal to the product of velocity and time.

$$\text{Distance traveled} = V \times t \qquad (1)$$

where distance = 2 × thickness in inches
t = time in seconds
V = a constant in inches/second (232,000 in./sec. for steel)

$$\text{Also: Time interval between recurring cycles} = \frac{1}{f} \qquad (2)$$

where f is frequency in cycles per second. Substituting (2) in equation (1),

$$2 \times \text{thickness} = V \times \frac{1}{f}$$

$$\text{Thickness} = \frac{V}{2f} \qquad (3)$$

Resonance conditions are also possible at exact multiples of the fundamental frequency, which are known as harmonics. For example, if the fundamental frequency fulfilling conditions in equation (3) is 1 megacycle (1,000,000 cycles per second), the second harmonic would be 2 megacycles, third 3 megacycles, etc., and the difference between any two adjacent harmonics would be equal to 1 megacycle, or the fundamental frequency. Therefore equation (3) can be modified so that

$$\text{Thickness} = \frac{V}{2(f_n - f_{(n-1)})} \qquad (4)$$

where f_n = nth harmonic of fundamental frequency
$f_{(n-1)}$ = Harmonic immediately preceeding the nth harmonic.

This ability to use the difference between any two adjacent harmonics makes possible a wide range of measurement. The frequency difference (or fundamental frequency) is inversely proportional to thickness, as shown in equation (4). A conversion scale, calculated from equation (3), is normally used to convert frequency to thickness. The conversion scale is essentially a circular slide rule, and is mounted on the instrument panel concentric with the tuning dial. The scale is set to the proper constant $\left(\frac{\text{velocity}}{2}\right)$, the pointer set on the frequency difference obtained, and thickness read on the adjoining scale. Frequency values on the conversion scale are expressed in terms of megacycles.

The velocity of propagation of ultrasonic waves is a function of the density and elastic constants of the material, and can be calculated from the following equation:

$$V = \sqrt{\frac{E}{P} \frac{(1-m)}{(1+m)(1-2m)}} \qquad (5)$$

where V = velocity in cm. per second
E = Young's modulus of elasticity in dynes/cm²
p = density in grams per cubic cm.
m = Poisson's ratio

By substituting the proper values in the equation, the velocity of sound in any elastic material can be found. The

TABLE 1

Comparison Between Instrument Readings and Actual Micrometer Measurements
(Data Obtained in Several Southwestern Refineries)

DESCRIPTION	Audigage Thickness	Caliper Thickness	REMARKS
Steel Block	.308"	.308"	Smooth surfaces.
8" Cast Iron Saddle	.890"	.885"	Smooth surfaces.
Section of Gasoline Storage Tank	.334"	.339" Peak .324" Valley	Reflecting Surface rough and pitted.
20" O.D. Vapor Line	.210"	.215"	Smooth external surface. Condition of interna surface not known.
28" O.D. Condenser Shell	.310"	.310"	Reflecting surface rough.
10'-0" Coke Chamber	—	1.93"	Both surfaces very rough.
H. F. Acid Regenerator Tower	.485"	.495"	Reflecting surface rough and pitted.
4" Pipe with ⅛" Coating of Carbon Inside	.298"	.305"	Surface comparatively smooth.

Figure 2. Instrument Being Used for Wall Thickness Measurements of a Large Pressure Vessel. Readings Taken from Inside of Vessel.

value for steel is approximately 232,000 inches per second. This value is approximately constant for different types of steel, and does not change appreciably with temperature, within the temperature range of the instrument.

In actual practice sound velocity for any material is usually found simply by measuring a specimen of known thickness. Known thickness and frequency can then be substituted in equation (3), and the equation solved for velocity.

Accuracy and Characteristics of Ultrasonic Resonance

Results obtained are directly dependent upon the surface characteristics of the material under test. When the surfaces are parallel and relatively smooth, a strong, sharp indication is obtained, and thickness can be read to within ±1 percent. If the surfaces are not parallel, or if there is a rough pitting of the metal surfaces, thickness indications which are obtained will be weakened and broadened in proportion to the amount of thickness variation. Accuracy in this case will be on the order of ±3 to ±5 percent. Examples of the accuracy obtained under field conditions are shown in Tables 1 and 2.

The instrument measures thickness of the area under the crystal detector head only, an effective area of about 1.5 square inches in the present design. It will not detect the presence of a small "pit" within this area, unless the area covered by the pit is substantial percentage of the total area covered by the crystal. If the corrosion is comparatively uniform under the 1.5-inch area, a rough average of the various thickness components will be obtained. It is sometimes possible to determine the total variation in thickness by interpreting the band of frequency resonances obtained from each thickness component.

No readings can be obtained if there is excessive variation in thickness under the 1.5-square-inch area. This limit is reached theoretically when the resonance frequency of the smallest thickness component is equal to the next higher harmonic resonance frequency of the largest thickness component under the crystal, or at integral multiples of these frequencies. Maximum and minimum thickness at this point can be expressed by substitution in equation (3):

$$x = \frac{V}{2\left(\frac{f}{n-1}\right)} = \frac{V(n-1)}{2f} \qquad (6)$$

$$y = \frac{V}{2\left(\frac{f}{n}\right)} = \frac{Vn}{2f} \qquad (7)$$

where: x = smallest thickness component in inches.
y = largest thickness component in inches.
n = harmonic number at which y is measured.
f = resonance frequency at the nth harmonic.

$$M = y - x = \frac{Vn}{2f} - \frac{V(n-1)}{2f} = \frac{Vn - Vn + V}{2f} = \frac{V}{2f} \qquad (8)$$

TABLE 2

Instrument Measurements on Furnace Tubes* Southwestern Chemical Plant

LOCATION	Thickness
1. Convection Bank	.4313"
2. East Side:	
North Bank	.410"
Center Bank	.420"
South Bank	.410"
3. West Side:	
North Bank	.410"
Center Bank	.420"
South Bank	.420"
4. Top:	
North Bank	.400"
South Bank	.420"

* Note: Tubes are 4" O.D. pipe with original wall thickness of .4375". Curved crystal detector head cut to fit 4" O.D. Pipe used in obtaining these measurements.

TABLE 3-A
Effect of Coupling Medium on Signal Strength
Flat Crystal Detector Head, 1½-Square-Inch Area
(Data Obtained by Branson Instruments, Inc., Stamford, Conn.)

Material Tested	Coupling Medium	Gauge Thickness	Sensitivity	REMARKS
Cold rolled steel, 0.308" thick, smooth surfaces.	Grease	0.310"	Over 100	Lowest indication, at .077 mc., hardly detectible with grease. Indication is sharp and distinct with Dow Silicone stc cock grease.
	Silicone Grease	0.305"	100	
.308" steel with hard and closely adherent scale on the reflecting surface.	Grease	0.310"	0.3	Meter indications practically unusable. Distinct audible signals at 1.8 and 1.83 mc. Low frequency indications not audible.
	*Glycerin-Aerosol	0.305"	4.6	Signals considerably stronger than with grease.
Steel ship plate, 0.560" thick, scale and slight pitting on reflecting surface.	Grease	0.544"	65	Sufficiently strong indications with grease.
Steel ship plate, deep pitting on reflecting surface, maximum .550" minimum .470".	Grease	0.500"	1	Very weak signal.
	Glycerin-Aerosol	0.495"	10	Sensitivity increased approximately 10 times by using glycerin.

* **Note:** Solution consisting of one gram of "Aerosol" per quart of glycerin. Aerosol serves as a wetting agent.

TABLE 3-B
Effect of Various Curved Crystals on Signal Strength
Glycerin-Aerosol Solution Used as Coupling Medium

Material Tested	Crystal Type	Gauge Thickness	Sensitivity	REMARKS
4½" O.D. steel pipe, slightly scaled, .556" wall.	Flat 1½ sq. inch area	0.550"	20	Use of proper curved crystal increased strength and sharpness of signals.
	4½" curved 1½ sq. inch area	0.550"	50	
5" O.D. heater tube with ⅛" coke deposit on inside .53" wall.	Flat 1½ sq. inch area	0.530"	25	
2⅝" O.D. steel pipe, scaled and corroded, 0.17" wall.	Flat 1½ sq. inch area	.....	0	No clear resonance indications obtainable.
	2⅝" curved, 1½ sq. inch area	0.175"	10	Use of curved crystal permitted measurement of this pipe.
6⅝" O.D. steel tube, 1¼" wall.	Flat 1½ sq. inch area	1.930"	5	
	6⅝" curved, 1½ sq. inch area	1.930"	50	Use of proper curved crystal increased sensitivity 10 times.

where: M = maximum thickness difference in inches.

When the velocity constant for steel is substituted, this equation becomes

$$M = \frac{.116}{f} \qquad (9)$$

where: f = resonance frequency in megacycles at the nth harmonic.

The practical limit in thickness variation encountered in actual field use of the instrument follows the theoretical limits closely. It has been found that a ½-inch plate with a "peak to valley" roughness of ⅛ inch can be measured with the present instrument. Since general corrosion in refinery equipment rarely exceeds this limit, the instrument can be used on approximately 90 percent of the equipment, dependent of course upon the type of process and corrosive conditions. Even though a reading cannot be obtained in a few cases, the operator does gain valuable information, the fact that there is serious corrosion on the unseen reflecting surface.

Scale, rust, liquids, or carbon formation on the reflecting surface does not affect the accuracy of the instrument, but tends to weaken the signal strength. This fact can often be useful in determining liquid level, or detecting the presence of carbon. Any discontinuity or change in the medium through which ultrasonic waves are traveling results in a reflection and a refraction occurring at the boundary. The ratio between reflection and refraction is proportional to the elastic constants of the materials, i.e., the velocity of ultrasonic waves. A large difference in velocity results in practically a complete reflection, as in the case of steel and air. Other materials adjacent to the steel, such as carbon, absorb a higher percentage of the waves, and therefore a weaker steel thickness indication results. If two layers of steel have only mechanical contact, there will be very little transmission of the wave across the boundary and therefore only the outer layer will be measured. However, when two layers of material with comparable sound velocities are bonded together, total thickness will be measured. Typical examples are glass, enamel, stainless steel, and nickel bonded to soft steel.

Satisfactory performance of the gauge on very rough materials, materials with a highly absorbent backing, or a combination of both, is determined by the "signal to noise ratio" of the instrument. Background noise is always present, and is increased when amplification is increased to detect weak signals. Therefore, a signal to noise ratio of the highest possible value is desirable.

Improvements in instrument design have increased signal to noise ratio considerably, and added increase can be obtained with coupling mediums more efficient than those normally used. A thin layer of grease or oil is usually used to transmit ultrasonic energy from the quartz crystal to the material under test, and is entirely satisfactory for most work. If additional sensitivity is necessary to obtain a satisfactory resonance signal, the use of a glycerin coupling medium will usually produce the desired results. Sensitivity on small diameter piping and other curved surfaces is increased by the use of quartz crystals ground to fit the curvature. Table 3 illustrates comparative values obtained by using the various aids to increased sensitivity. The sensitivity, S, is defined as follows:

$$S = \frac{I_1 - I_2}{I_2}$$

where: S = sensitivity
I_1 = current, in milliamperes, at a resonant frequency (Signal level).
I_2 = current, in milliamperes, at other frequencies (noise level).

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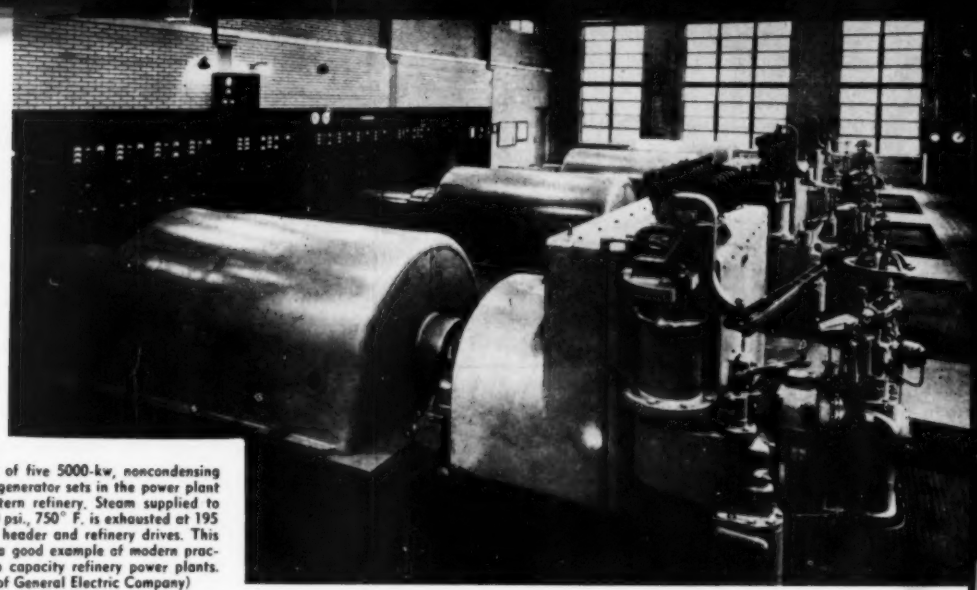

Figure 1. Four of five 5000-kw, noncondensing steam turbine-generator sets in the power plant of a Mid-Western refinery. Steam supplied to turbines at 650 psi., 750° F. is exhausted at 195 psi. to process header and refinery drives. This installation is a good example of modern practice in medium capacity refinery power plants. (Courtesy of General Electric Company)

Power Plants for Modern Refineries

PART I

TYLER G. HICKS, Hicks Associates, New York

***POWER** plants serving today's refining, natural gasoline, and petrochemical plants have come a long way since the well-known "oil-field" boiler days. No longer is steam generation the only function of the refinery power plant. Electricity in large quantities becomes more necessary every time a new production operation is introduced. With the decrease in availability of by-product fuels, refinery power plant efficiency takes on a new importance. To achieve low cost production, today's refinery designer must strive for the optimum balance obtainable between process and power generating facilities. Obtaining such a balance is not readily done because it involves a multitude of factors.*

FOR many years two factors controlled refinery power plant design: 1) availability of low cost fuels, and 2) small demand for electric power. As a result the power plant was neglected as place where production costs could be reduced. Design lagged considerably behind prevailing central station and industrial plant practice. Low steam pressures, about 200 psi., were common until 20 years ago, although central stations had been using pressures of 1200 psi. for several years prior to that.

Much criticism was levelled at refiners for their lack of interest in power plant development. Many of the high pressure-high temperature piping problem solutions first evolved by refiners were quickly adopted by central station and industrial plant designers for use in their power houses. Refiners in general, however, continued to operate at about 200 psi. when they could have readily installed equipment for higher pressures and temperatures.

Figure 2 shows a typical flow diagram for a refinery power plant of the early 20's. Production facilities by that time had reached the stage where a small amount of electric power was required in addition to large quantities of low pressure steam. Required electric power was produced by one or more turbines. Process steam was supplied from three sources: a large battery of old boilers, exhaust from newer turbines, and by pressure-temperature reduction from the higher pressure steam main.

Although plants of this type produced the needed steam and electric power, their operation from a thermodynamic standpoint was not the most efficient obtainable. During periods of low refinery production, valuable steam was exhausted to the atmosphere instead of being used somewhere in the power plant cycle. This was the principal defect of these plants, lack of balance between steam generation and refinery production facilities. To obtain a better heat balance higher steam pressures and more efficient turbines were needed. Many years passed before most refiners adopted them.

Other Developments

During the years that most, but not all, refinery power plants were operating on low pressures and temperatures, central station and industrial plant practice changed considerably. Superposed, extraction, and mixed-pressure turbines came into wide use with a resulting large reduction in overall-heat rates because the same amount of heat was rejected to the condenser before and after superposed turbine installation. Power developed by these turbines was far greater than any other type turbine in use. When equipped with superposed turbines many old

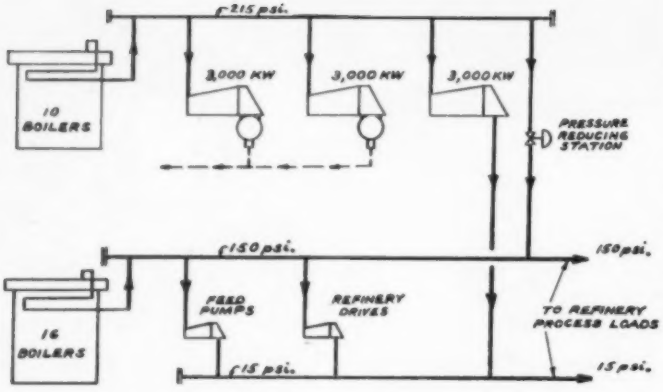

Figure 2. Above flow diagram of a typical refinery plant of the early 20's. Low-pressure steam produced by a large battery of boilers and small electrical capacity were the principal characteristics of these early plants. The flow diagram of the modernized plant is shown in Figure 4A.

plants were able to generate as much as 30 percent more power using the same amount of fuel. In addition, increased condensing-water flow was not required, an important factor in regions where the water supply was scarce.

Four new cycles were applied to industrial plants using superposed, extraction, or mixed-pressure turbines. The simplest, Figure 3A, permitted large savings in existing low pressure plants. Steam, generated at a pressure higher than in the existing boilers, passes through the superposed turbine and exhausts to the old turbines and process header. The second cycle, Figure 3B, employs one extraction stage from which steam is bled for use in the existing low pressure turbines. The superposed turbine exhausts to an intermediate pressure process header and the existing low pressure units to another, lower pressure, process header. Excellent for plants with con-

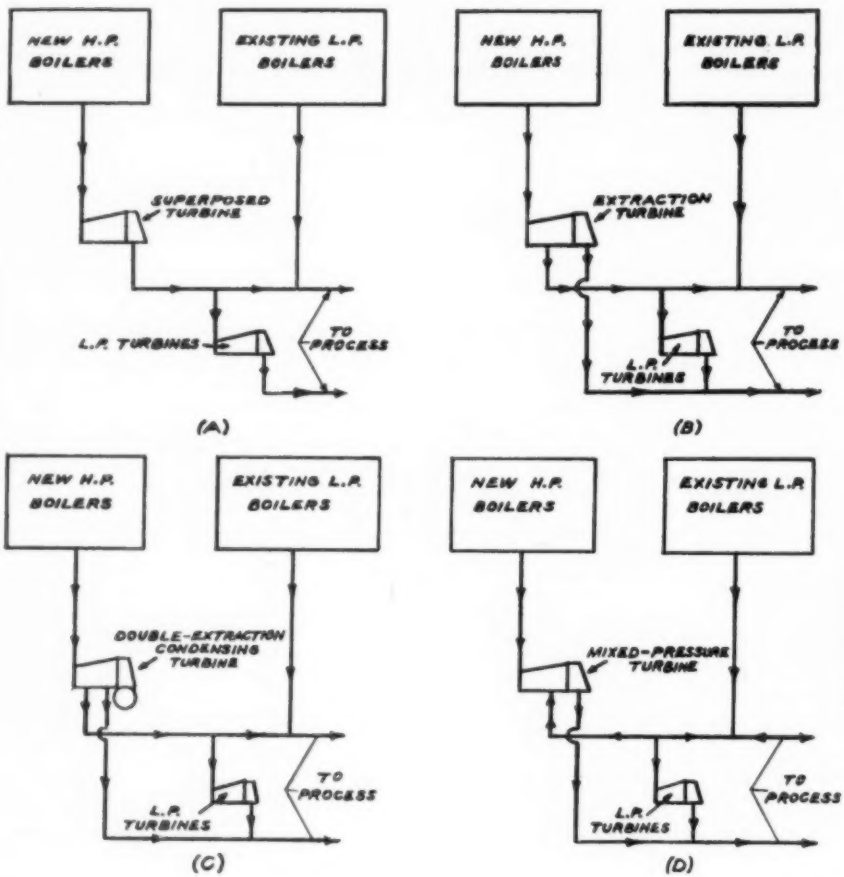

Figure 3. Industrial steam cycles for improving over-all plant economy and power-process balance. Today one or more of these cycles is used in every refinery power plant generating process steam and electrical power.

densing turbines, this general cycle was later used in several large refineries. The third cycle, Figure 3C, uses two stages of extraction from a condensing type turbine. One stage supplies existing low pressure turbines and the other the low pressure process header. To utilize excess low pressure steam, the mixed-pressure turbine, Figure 3D, was introduced. Process steam which cannot be used during periods of low production is allowed to flow back into the turbine where it helps to generate electrical power.

Each cycle permitted an increase in power and process steam production without a large increase in fuel consumption. All necessitated use of higher steam pressures and efficient turbines. Thus, three of the major requirements of rapidly advancing refinery practice were met: 1) more electric power, 2) more process steam, and 3) better power-process balance, all obtainable with only a moderate increase in fuel consumption. The refiner, with his mettallurgical studies and techniques, made these cycles possible but in many cases waited until his low-pressure power plant was overloaded before taking advantage of the cycles. Once started, he took full advantage of each cycle, in many instances combining them to suit his needs. Results obtained are not only interesting, they are indicative of future trends in refinery design and operation.

The Modern Refinery Power Plant

For the first illustration of the modern type power plant the flow diagram of Figure 2 has been reproduced in Figure 4A to show how additional equipment was balanced with the existing plant and process load. The plant in Figure 2 operated from 1923 to 1938, by which time the process steam and power demands began to exceed plant capacity. A study of the refinery indicated that a 600-psi. plant operating with 150-psi. backpressure would provide the best facilities for the increasing process load. Three 300,000-pounds-per-hour boilers operating at 615 psi. and 715 F. supply steam to three 7500-kw. turbines superposed on refinery drives. Two of these turbines exhaust at 150 psi. and the third, of the mixed-pressure type, has a 150-psi. extraction connection. In addition, excess steam from the 15-psi. process header can flow to the mixed pressure turbine. High-pressure steam not required by the three turbines flows through the pressure reducing valve and desuperheater to the 150-psi. process header.

When completed in 1940, this plant provided one of the best power-process balances obtainable at that time. No steam was wasted to the atmosphere, turbines were high efficiency units, and several fuels could be used. Refinery gas was the main fuel but natural gas, oil, and a refinery-natural gas mixture could also be burned. Arrangement for future burning of pulverized petroleum coke was provided. For best efficiency, refinery base load was carried by new boilers and demand fluctuations cared for by the old 150-psi. boilers. Initial structural costs were reduced by outdoor installation of the new boilers with a one-story structure to house controls, firing aisle, and fuel and feed

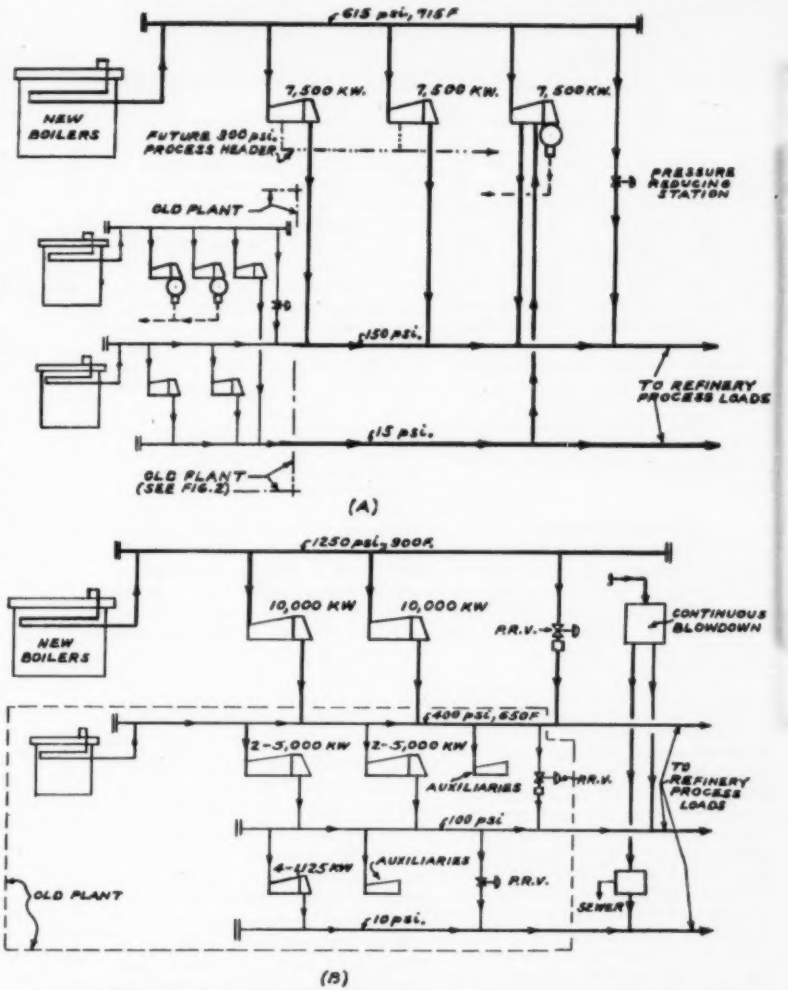

Figure 4. Flow diagrams of modern refinery power plants. (A) New plant superposed on old plant shown in Figure 2. Cycle arrangement provides an excellent power-process balance together with large generating capacity. (B) Mid-Western plant is outstanding for its use of high-pressure steam, large capacity generators, and dual circulation boilers.

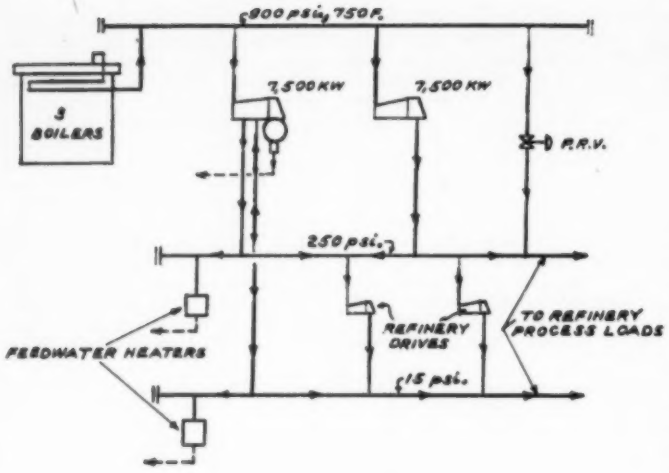

Figure 5. Flow diagram of a modern, medium capacity East Coast refinery. Cycle arrangement provides for maximum operating economy by use of all steam generated. Steam pressures and temperatures used in this plant equal those common in other industries.

pumps. Extensive motorization of refinery drives would have been necessary if three superposed turbines had been used instead of two in combination with a mixed-pressure unit. This resulted from design logic; i.e., it would have been poor design to install three superposed turbines and waste excess low pressure steam. Also, if refinery drives were changed from turbines to motors to absorb the additional power produced by excess low pressure steam, initial costs would be high. Hence, the mixed-pressure unit in combination with superposed units provided greatest flexibility and efficiency.

Design Changes

Ten years later, in 1948, a midwestern refinery installed a superposed plant which equals in performance many of the largest industrial plants in the country. Steam generated at 1350 psi., 900 F., enters two superposed, 10,000-kw. turbines at 1250 psi., 900 F. and exhausts to an existing 400 psi., 650 F. process header, Figure 4B. From here it goes to four 5000-kw. turbines, auxiliaries, or a pressure-temperature reducing station. The next pressure level is 100 psi. for process, power generation, and auxiliary drive. Lowest pressure level, 10 psi., supplies process demand and feedwater heaters. The original 400-psi., 650 F. plant installed in 1928 was one of the first superposed turbine cycles in the country and was quite successful.

This installation well illustrates savings resulting from superposition. Every thousand pounds of steam at 1250 psi. which pass through the new turbines and are later used in the refinery at 400 psi. produce about 30 kw. of power. To generate this steam at 1250 psi. instead of 400 psi. requires only about 10 percent more fuel. Oil, gas, or pulverized coal can be burned in the two new 300,000-pounds-per-hour boilers. In this refinery, as in many others, steam driven auxiliaries have gradually been replaced by motor driven units to utilize the low cost superposed power output. As a result plant generating capacity is large compared with that of the older refineries.

The flow diagram for a new East Coast refinery power plant is shown in Figure 5. This plant is of much interest because both power and process facilities were put into operation for the first time in 1949. Three 275,000-pounds-per-hour boilers burning gas or oil supply steam at 900 psi., 750 F. to two 7500-kw. turbines. One turbine is a superposed unit exhausting to the process header at 250 psi. and the other is a mixed-pressure-extraction induction type. The unit can supply extracted steam at 250 psi. and 15 psi., use excess process steam at 15 psi, and exhaust to a condenser at 27.5 inches of mercury. Two pressure-temperature regulating stations provide for flow between 900 psi. and 250 psi. process header. Refinery drives use 250-psi. steam, a pressure higher than that used in the main steam headers of most old refineries. Drives exhaust to the 15-psi. process header. Feedwater treatment cycle, utilizing two softeners, a battery of filters, and a deaerator, provides good control of raw water impurities and dissolved oxygen. Entire design is well balanced and flexible with provisions for future increase of process output.

Statistical Comparisons

The general descriptions and flow diagrams of these modern plants present a clear cross-section of modern refinery power plant types. However, a better over-all concept of what is happening in refinery power plants is obtained when today's installation figures are compared with those of yesterday. For instance, in the 12-year period between 1927 and 1939 about 85 high-pressure industrial power plants (500 psi. or greater steam pressure), went into operation. Only eight, or less than 10 percent, were refinery power plants. Of 110 industrial plants reported starting operation between 1945 and early 1949, 25 or more than 22 percent were for refinery service. Nine industrial power plants operating at 900 psi. or more went into service in 1948 and four of these, or almost 50 percent, were refinery units. The highest pressure industrial power plant installed during 1948 was for refinery use.

Thus it can be seen that refinery power plants are now on equal footing with those of any other large industry in the country. Besides, process steam and electrical loads are at an all time high. Many refineries now use 1.5 million or more pounds of steam per hour for process loads. Electrical loads of 35,000 kw. are common. These figures represent a good chunk of the industrial steam and power generated in privately owned plants. It is interesting to note that increase in refinery steam demand has not kept pace with the rise in electrical demand. In many cases this difference results from partial or complete motorization of refinery drives.

Refiners have not confined their power plant studies to the steam cycle alone. Waste heat generation of steam, low cost construction methods, specially designed plants for petrochemical and natural gasoline operations, and cooperation with utility plants supplying refinery power and steam have been developed and utilized. Advances of this type changed, in many cases, the older concepts of refinery design, operation, and maintenance. Major advances will be discussed in subsequent articles.

End of Part I. Part II will appear in an early issue.

***WHILE THE** accompanying article lays great stress upon transportation, it will prove of high interest to plants selling liquefied petroleum products since many accidents seem to occur at plant loading racks.*

The author has been working with the API and National Safety Council committees on this subject and the facts and information brought out at these meetings are presented herewith primarily in order to arouse discussion and study.

Accounts of the experiences and practices at other plants are invited and may be addressed to the Editor.

Snapshot of actual flammable liquid fire showing extent and severity of such type fire.

Safe Practices In Handling Flammable Liquids

DON ATTAWAY

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THE greatest potential danger in handling flammable liquids in tank trucks is from fire or explosion resulting from the release of vapors and the possible ignition of these vapors.

Fires at loading and unloading racks, however, are not the most prolific source of accidents but they are generally the most destructive and costly type of mishap. The loader usually works above ground and is exposed to the danger of slipping and falling. He is exposed to strains, sprains, and cuts while handling hoses, wrenches, and valves. When considerable vapors are released, he is subject to sickness and even asphyxiation from inhaling these vapors. It is from such causes as these that most accidents in loading and unloading trucks occur.

In view of the fact that fires and explosions are so disastrous, this article will confine itself largely to those safe practices in handling flammable liquids.

In order to establish an understandable premise, the term "flammable liquids" will be defined as any liquid having a flash point below 200° F. and a vapor pressure not exceeding 40 pounds, which for the purpose of this article, shall be divided into two classes, viz.:

Class "A" embracing flammable liquids having a flash point below 70° F. and a vapor pressure of not more than 40 pounds.

Class "B" embracing those flammable liquids having a flash point from 70° to 200° F., inclusive.

The flash point in each class to be determined by means of a closed cup tester only. It has been recognized for some time that considerable difference exists between results obtained when using different types of flash testers as shown by Table 1.

TABLE 1

Comparative Flash Point Readings by Different Testing Devices

MATERIAL	Abel	Tag	Pensky Martens	Cleveland Open-Cup
Naphtha	86	92	95	100
Kerosene	127	130	135	140
Gas Oil	....	....	195	200

The vapor pressure of the product shall be that resulting from a test using the Reid method as specified by ASTM Method D323-43, which is also the API Method 539-43. This test is to determine the volatility or tendency of the liquid to vaporize.

The above two tests are important factors in determining the flammability of liquids. The hazards increase as the flash point lowers or as the vapor pressure rises. But other factors also enter into the problem and should be taken into consideration in establishing safe practices.

Ignition temperature is the lowest temperature at which a flammable mixture will ignite solely by heat. For instance certain commercial gasolines will ignite at temperatures between 500 and 600° F. so that hot metal surfaces at this temperature will set them off.

Flammable liquids also have a minimum and maximum concentration of vapor in air or oxygen below which flame propagation does not occur on contact with a source of ignition. These concentrations are usually expressed in terms of percentage by volume of gas or vapor in air and are called the "upper and lower flammable limits." The difference between the lower and upper limits is often referred to as the "explosive range."

For example, any mixture with less than 1 percent of gasoline vapor is too lean and seldom will propagation of flame occur on contact with ignition. On the other hand, if there is more than 6 percent of gasoline vapor,

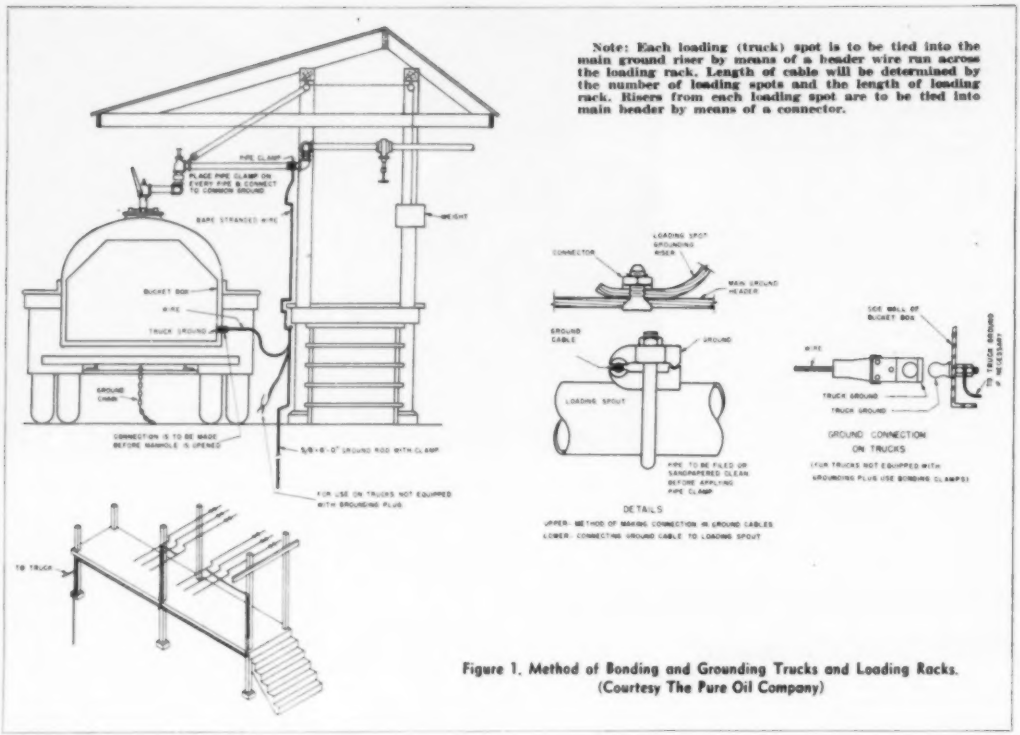

Note: Each loading (truck) spot is to be tied into the main ground riser by means of a header wire run across the loading rack. Length of cable will be determined by the number of loading spots and the length of loading rack. Risers from each loading spot are to be tied into main header by means of a connector.
PLACE PIPE CLAMP ON EVERY PIPE & CONNECT TO COMMON GROUND
BARE STRANDED WIRE
BUCKET BOX
WIRE
TRUCK GROUND
GROUND CHAIN
CONNECTION IS TO BE MADE BEFORE MANHOLE IS OPENED
FOR USE ON TRUCKS NOT EQUIPPED WITH GROUNDING PLUG
TO TRUCK
CONNECTOR
LOADING SPOT GROUNDING RISER
MAIN GROUND HEADER
GROUND CABLE
GROUND
LOADING SPOUT
PIPE TO BE FILED OR SANDPAPERED CLEAN BEFORE APPLYING PIPE CLAMP
DETAILS
UPPER: METHOD OF MAKING CONNECTION IN GROUND CABLES
LOWER: CONNECTING GROUND CABLE TO LOADING SPOUT
SIDE WALL OF BUCKET BOX
WIRE
TRUCK GROUND
TRUCK GROUND
GROUND CONNECTION ON TRUCKS
(FOR TRUCKS NOT EQUIPPED WITH GROUNDING PLUG USE BONDING CLAMPS)

Figure 1. Method of Bonding and Grounding Trucks and Loading Racks. (Courtesy The Pure Oil Company)

the mixture is too rich, and will not burn. Other gases have wider explosive ranges. In any event, a knowledge of these ranges is important in establishing safe practices for handling flammable liquids.

The tendency of a gas or vapor to disperse or mix with another gas or vapor is called the rate of diffusion. This rate is established by a comparison with air density usually giving air the value of 1. Whether a vapor is lighter or heavier than air determines to a large extent the method of solving ventilation.

An atmosphere that lacks sufficient oxygen for a safe working area is said to be deficient in oxygen. Normal air contains about 20 percent oxygen at atmospheric pressure. If about 17 percent of the air is oxygen, men at work must breathe deeper or faster. When the content is reduced to 15 percent men usually become dizzy, note a buzzing in their ears, or have a rapid heart beat.

Although men do not usually lose consciousness until very much less than 16.25 percent of oxygen is present this is the point where flame safety lamps are extinguished.

Truck loaders using open dome operations with very volatile liquids having heavy vapors have been found working in areas with oxygen content less than 15 percent. This is hazardous and if the air contains as little as 10 percent oxygen, life is greatly endangered.

No man should work in such areas without self-contained oxygen breathing apparatus or fresh-air hose mask.

Tank Truck Operation

Tank trucks, tank trailers, tank semi-trailers, or cargo tank trucks used for the transportation of flammable liquids should be constructed and operated according to the regulations of the Interstate Commerce Commission Motor Carrier Safety Regulations, and the Regulatory Standard for Tank Trucks for Flammable Liquids as adopted in 1948 by the National Fire Protection Association.

Such trucks should be kept in good repair and condition and be given *daily* inspections. Special attention should be given to the condition of lights, brakes, horn, rear view mirror, bonding, tires, and steering. As a safe practice, the safety and excess flow valves should be tested frequently.

One of the most common sources of ignition is smoking. Truck drivers, loaders, and their helpers should not be permitted to smoke while driving, loading, unloading, or making repairs. They should be alert to keep away other smokers or sources of ignition whether the truck is loaded or not.

As a safe practice, drivers and loaders who smoke should not carry matches or single action lighters. The safest lighter is a closed or double-action type. Cases have been known where single-action lighters have been accidently dropped in such a way as to cause the lighter to spark upon contact with another object or the ground. Matches have also been accidently ignited by friction or an accidental blow while they were in the driver's pocket.

Static electricity should not be confused with stray currents. Static is a type of electrical charge resulting from the contact and separation of two substances, one or both of which are non-conductors. The movement of a truck through the air as it drives down the highway generates static. The contact and separation of the tire tread on the road surface generates

static. Charges are also produced when liquids are pumped through lines and hose. High voltages may accumulate at nozzles.

Actual cases have been known where static sparks were produced when a truck driver slid across nylon or plastic seat covers in getting out of his truck cab.

Tests have shown trucks having potential static charges of less than 300 static volts do not produce sparks of sufficient intensity to ignite vapors. Furthermore, static generation and accumulation is more severe in dry, cold weather than during humid, warm weather. Tests made of tank trucks at a refinery gate showed them to have accumulated charges from 2335 volts to 3025 volts.

Static is a very potential source of ignition and must be assumed to be present at all times; therefore, all trucks and loading docks or racks must be electrically bonded before any operations are started.

Another series of tests showed trucks not equipped with drag chains to have charges as high as 16,000 volts but trucks equipped with drag chains had charges as high as 9500 volts and static sparks sufficient to ignite vapors were produced.

Drag chains are generally conceded to be of little or no benefit. They are not construed by the National Fire Protection Association as meeting the requirements of bonding. Tests conducted over a number of years under a wide variety of conditions have indicated that drag chains are obsolete and have no place in flammable liquids tank truck fire protection. In fact, they are a nuisance and often a hazard. Cases have been known where drag chains on gravel and concrete roads have produced sufficient sparks to ignite vapors and in several instances chains have hung on road projections or objects and caused links to be shot like bullets into the tank bodies or cars following the tank truck.

Fire fighting demonstrations are excellent training mediums for new employes.

Nevertheless many local laws and ordinances continue to require the use of these remnants from an age when fire protection was based on guesses rather than facts and evidence.

Care should be taken in starting the engine after loading so as not to cause it to backfire. In case of spillage or heavy vapors in the air, a hot piece of burning carbon may ignite the mixture.

Electrical Ignition

Sparks from the truck or loading rack electrical equipment can also ignite gases or vapors. Shorts in wiring may produce these sparks or even the making and breaking of circuits by means of a switch. All electrical fittings at loading racks should be enclosed within explosion-proof fittings according to the National Electrical Code for Class 1, Hazardous Locations.

Spills and overflows should be avoided but if they do occur, loading should be stopped, valves shut off, and the overflow cleaned up or flushed away before resuming operations.

In case of a leaky truck, the driver should make every effort to park a damaged truck in such a way that it will not endanger traffic or property. The public should be warned to keep away and the police and fire department notified.

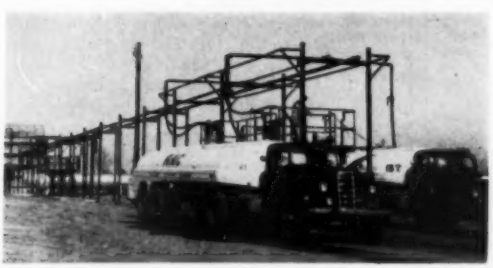
Leaking trucks should never be parked on a highway. A vacant lot or side road away from buildings or areas in which people are concentrated is safer. The leaking liquid should be trapped into containers, a ditch or pit, but never into sewers or streams.

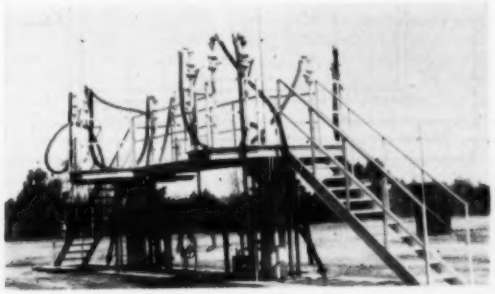
As a safe practice loaded trucks should not be operated on highways at night, nor left parked where passing traffic may strike them. In case of emergencies, parked trucks whether empty or loaded should be properly flagged and marked with lights or flares placed at a safe distance.

While loading or unloading, the truck brakes must be set and loaders or drivers should never leave their operations without shutting off all valves. Care should be taken that the correct product is being handled and that the tank has previously contained the same liquid. Otherwise the tank should be completely drained and flushed.

In connecting and disconnecting lines, proper tools should be used. Rubber hoses should be handled with care to prevent kinks or breaks, and carefully drained so that spillage will not saturate the loading area or cover the truck body.

Left—A variation of the sub-type truck-loading rack, using overhead lines. Right—An excellent tank truck loading rack arrangement using sub-type platform and underground header.





Caps, compartment covers, or domes must be carefully replaced on loaded trucks to be sure that leakage will not occur. All tools and fittings used in the operation must be returned to their proper place.

Loading or unloading operations should not be started or continued during an electrical storm.

Adequate and safe walkways from truck to loading platform should be provided. Loaders should never jump from the rack to truck or truck to rack.

During all filling operations, bonding contact shall be maintained until the tank has been closed and sealed. It is a safe practice for the driver to make one complete walking circuit of his truck to check for any unsafe condition, before starting the motor to drive away.

Each tank vehicle shall be equipped with at least one approved hand fire extinguisher of a type suitable for extinguishing flammable-liquid fires. Carbon dioxide and dry chemical are excellent types and should be mounted in a convenient safe place. Usually the fire extinguisher is easily attached to the *right* side of the truck near the cab, on the running board, or in a bracket inside the cab.

Extinguishers should not be mounted on the front bumper or on the tank proper where they may be subject to damage or inaccessible in case of fire. To insure perfect operation the extinguisher should be protected with a hood or covering and inspected at frequent intervals.

Tools used in loading or unloading operations should be of the spark-resisting type.

As a safe practice goggles should be provided for use in case of spills or splashes. Certain companies also provide their personnel with asbestos gloves for use in making emergency shut-offs in case of fire. Other companies equip each truck with a shovel for use in ditching or making pits in case of leakage or spillage.

Each rack should have adequate fresh air or oxygen type masks for emergencies.

All racks should display "No Smoking" signs in restricted areas. Warning signs at gates and entrances should be erected to prohibit trespassers.

All flashlights used should be of the safety type approved for use in areas where flammable vapors are present.

Personnel should give consideration to type of clothing worn while working in and around flammable vapors. Shoes with exposed nails or metal cleats are capable of knocking sparks in metal to metal contact. Woolen, silk, and rayon cloth can generate static and may become impregnated with dangerous amounts of vapor or liquid in contact with the body. Cotton clothing is safer and shoes with non-metallic or sewed soles are better.

In the event of a tank truck fire while loading or unloading, the fuel supply should be immediately shut off If loading, the spout or hose should not be removed from the tank truck, as a spill may result and spread the fire. In case of a burning dome or fill opening, the fire can be attacked with carbon dioxide or dry chemical or the opening covered with wet sacks or a blanket.

In the event of a spill fire, foam or vaporizing liquids may be used in the absence of carbon dioxide or dry chemical. If an adequate supply of water is available, the burning liquid may be flushed away to a safe place (not a sewer).

Burning vapors from vents, relief valves, or leaks may be safely allowed to burn if the source of the escaping liquid or vapor can be shut off or controlled.

Above all, calmness and direct action are required rather than excitement and haphazard fire fighting. Flammable liquid fires are easily controlled or extinguished if proper equipment and methods are used. Such fires seldom go out of control if correct action is taken at the proper time.

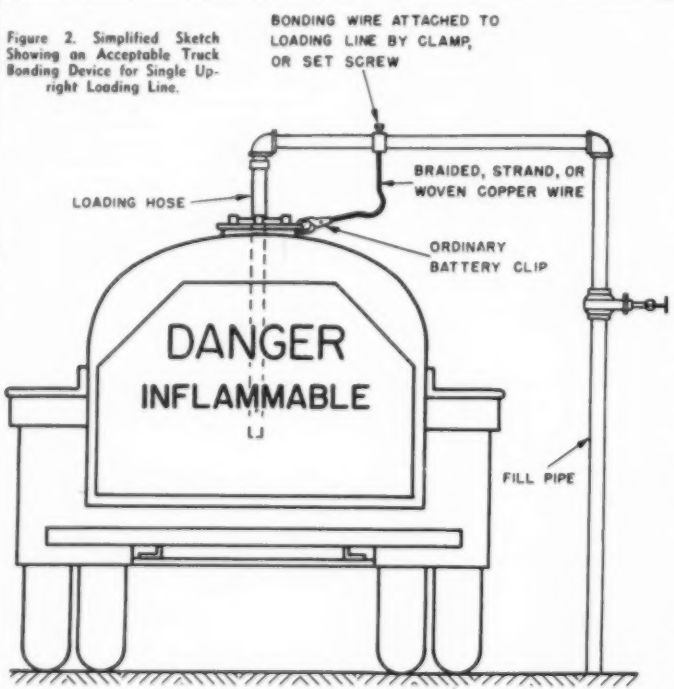


Figure 2. Simplified Sketch Showing an Acceptable Truck Bonding Device for Single Upright Loading Line.

Personnel

In view of the requirements of a complete knowledge of the behavior and characteristics of flammable liquids, it is very important that only those men physically fit and properly trained in safe procedure should be used for the handling and loading of flammable liquids.

The personnel in charge of tank trucks and loading racks must be familiar with the rules and regulations relative to the handling of such liquids and to follow the procedure in detail.

Drivers should be fully qualified and capable of operation of their vehicle with complete knowledge of the traffic rules and regulations relative to city and highway operation. The safe practices and courtesies of a careful driver should be followed.

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The Determination of Inorganic Chlorides In Crude Oils

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***EXPERIENCE** has taught refiners that salt should be removed from crude oils to avoid plugging heat exchangers and fractionating equipment, as well as to avoid extensive corrosion from hydrolysis of the chlorides to hydrochloric acid during the distillation process. The removal of the salt is accomplished in the refinery in a variety of ways, most of which rely on some method of water washing to dissolve the salt. The efficiency of the desalting process must be controlled from the laboratory, so it is necessary to have an accurate and rapid means of determining the salt content of the crude oil before and after desalting.*

The authors both are connected with Globe Oil & Refining Company, Lemont, Ill., Mr. Krause as chief chemist and Mr. Dystrup as assistant chief chemist.

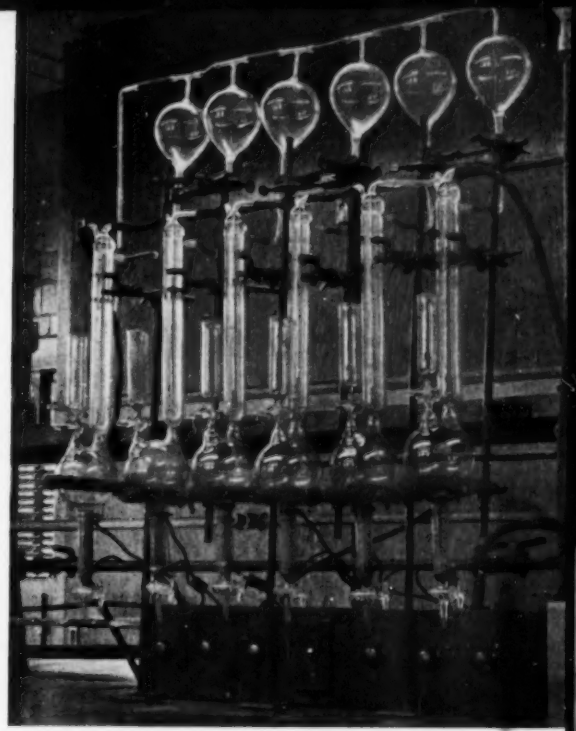

Figure 1. Extraction Apparatus for the Determination of Inorganic Chlorides in Crude Oils.

THERE are numerous references in the literature to methods for the extraction and analysis of chlorides in crude oils. Our interest has been in the development of a rapid, yet accurate, method adaptable to the analysis of several samples at a time. The U.O.P. method, has been regarded as an accurate, standard procedure, but it is time consuming because the extraction is carried out in a separatory funnel by hand agitation of a mixture of the crude oil, benzol, acetone and hot water. It is usually necessary to repeat this procedure at least once to completely remove the salt.

In the procedure recommended by Blair[2] a mixture of the sample of crude oil and xylene is agitated with hot water using a "destabilizing compound" to break the emulsion. One extraction, it is claimed, is sufficient. To eliminate the time spent by the analyst in shaking a separatory funnel Rittershausen and DeGray[3] recommended the use of the ASTM tetraethyl lead extraction apparatus. In their procedure the salt is extracted from the crude oil diluted with xylene by hot water using N-butyl alcohol to break the emulsion.

The Mohr method, using potassium chromate indicator for the analysis of the extracts, was recommended in each of the foregoing procedures. More recently the chloride content of the crude oil has been determined directly (without extraction) by electrometric titration[4]. This method is accurate but has the disadvantage of the cost of the recommended Precision-Shell dual titrometer.

It was found in our laboratories that the potassium chromate indicator was relatively inaccurate when used on the extracts of crude oils containing less than 10 pounds of salt per 1000 barrels of oil. In many cases the blank titration correction was larger than the amount of silver nitrate used for the titration of the extract. Thus the routine analysis would show zero salt content on the desalted oil but more careful analysis by other methods would show 3-6 pounds per 1000 barrels. By careful review of existing methods and study of the problem a method was developed that gives greater accuracy on the low salt content oils as well as the ability to make several analyses simultaneously.

The evolved method is both rapid and accurate. It has been in daily use in the laboratories of Globe Oil & Refining Company, Lemont, Ill. for several years and requires neither expensive equipment nor technical personnel. It has been possible to run analyses for salt content of six samples of crude oil with little more time or attention than that required for a single analysis by the hand extraction methods. A battery of six tetraethyl lead extractors are used for the extraction process which makes it possible to analyze six samples within an hour. An added advantage is that only 30-40 minutes of this time is required as actual attention and work by the operator.

Briefly, the method consists of an extraction of the salt in the crude oil by a slightly acid aqueous solution in an ASTM TEL. extractor using benzol to reduce the viscosity of the oil and acetone to promote more vigorous mixing of the two phases as well as to serve as an emulsion breaker. After cooling and careful neutralization the total chloride is titrated with standard silver nitrate solution using dichlorofluorescein as the indicator. To improve the accuracy of the dichlorofluorescein indicator on low salt content extracts a measured amount of standard chloride is added in cases where the salt content is less than 30 pounds per 1000 barrels. The dichlorofluorescein indicator gives much sharper color change than chromate indicator, the color change being from yellow to salmon pink.

Method of Analysis

Apparatus (see Figure 1)—

Tetraethyl lead extractor, ASTM designation: D526-46T, complete with heating coil, brass terminal connections, and rheostat.

Trap system for extractor (To avoid loss of sample in case of severe boiling).

One hundred ml. graduated cylinder.

Two 10-ml. burettes with 0.05-ml. graduations.

Two 25-ml. burettes with 0.1-ml. graduations.

Reagents—

Benzol, industrial grade.

Acetone, industrial grade.

Sulfuric acid, 0.1 percent. 1 gm. C.P. 96 percent sulfuric acid per liter.

Sodium hydroxide, 0.5 percent. 5 gms. C.P. sodium hydroxide per liter.

Sodium chloride, 0.05N. 2.923 gms. C.P. sodium chloride per liter.

Silver nitrate, 0.05N. 8.494 gms. C.P. silver nitrate per liter.

Brom thymol blue indicator, 0.04 percent solution.

Dichlorofluorescein indicator, 0.1 gm. of the indicator is dissolved in 60 ml. of alcohol, 2.5 ml. of 0.1 N sodium hydroxide is added, and the volume is made up to 100 ml. with distilled water.

Procedure—

Measure into the extraction apparatus 100 mls. of crude oil, 50 mls. of benzol, 25 mls. of acetone, 95 mls. of distilled water, and 5 mls. of 0.1 percent sulfuric acid. Adjust the rheostat for maximum heat until the mixture has been brought to the boiling point, then readjust the rheostat to the point at which there is vigorous agitation but not surging into the condenser. Extract in this manner for 20 minutes. Switch off the heat and allow the aqueous layer to completely settle. Withdraw this layer and cool to room temperature. Carefully adjust the acidity of the extract, using the 0.5 percent sodium hydroxide solution, to the brom thymol blue endpoint, the color change being from yellow to blue. Add 10 drops of dichlorofluorescein indicator and titrate with standard silver nitrate solution to a permanent pink coloration.

A second extraction of raw crudes is recommended as a precautionary measure. If the first and second extracts are titrated separately, it can be determined by experience whether the re-extraction is necessary or not.

Chloride content (lbs./1000 bbls. as NaCl) = 10.23 × Mls. 0.05N silver nitrate required where the factor 10.23 represents the conversion of the sodium chloride, equivalent to one ml. of 0.05 N silver nitrate, from mgs. per 100 mls. to pounds per thousand barrels.

In those cases where it is expected that the salt content will be less than 30 pounds per 1000 barrels, add by means of a semi-micro burette, 5.0 mls. of 0.05 N sodium chloride solution to the extract before the titration is made. Then,

Chloride content (lbs./1000 bbls. as NaCl) = 10.23 (Mls. 0.05 N $AgNO_3$ required — Mls. Blank), where the Blank represents the volume of silver nitrate (0.05N) equivalent to 5.0 mls. of 0.05 N sodium chloride.

Discussion

Selection of solvents—

Organic solvents are used to lower the viscosity of the crude oil to be extracted. Benzol was used specifically because it has the lowest boiling point of the aromatic solvents. Aromatic solvents are used because they do not cause a precipitation of asphaltic type material when mixed with crude oil. It was found that acetone not only served the purpose of breaking the oil and water emulsion but that it also promoted a more vigorous agitation of the two phases during the extraction resulting in a greater recovery of salt.

Effect of Addition of Acetone on Recovery of Salt

Amount of acetone added	Nil.	25 ml.
	Chloride Content in P.T.B.	
Kansas Crude Oil	54	66
West Texas Crude Oil	268	316

Extraction in an acid medium—

In those cases in which desalting is accomplished in the refinery by mixing the crude with water, caustic soda or soda ash is usually added to neutralize any free acids. Some difficulty was encountered in the laboratory in the titration of the extracts from these alkaline crude oils. It is thought that this trouble was caused by soaps. The difficulty was eliminated by extraction in an acid medium as directed in the procedure.

Choice of indicators—

When the salt content of a crude oil is very small, such as is the case with desalted oils, it is quite difficult to determine the endpoint using potassium chromate as an indicator. Further, in both the standardization and extract titrations, it is necessary to consider the potassium chromate blank. This perhaps wouldn't constitute a serious objection to the use of potassium chromate but for the fact that the blank is also quite difficult to determine accurately. To overcome these difficulties, dichlorofluorescein was selected—the indicator blank is negligible, the endpoint is very sharp, and as a consequence very accurate results are obtained. It is necessary, however, to add standard sodium chloride to those extracts containing less than 30 pounds per 1000 barrels, since a concentration smaller than this does not provide as distinct a change nor as deep a color as do the higher concentrations.

Comparison of Results Using Potassium Chromate and Dichlorofluorescein Indicators

Salt Content (P.T.B.) of Desalted Crude Oils	Salt Content (P.T.B.) using Potassium Chromate as the Indicator	Salt Content (P.T.B.) using Dichlorofluorescein and 5.0 ml. 0.05 N NaCl
1	0	1
3	0	4
7	2	7
7	1	6
6	1	7
6	0	6
4	0	5
6	0	5
8	3	9
7	2	7

Comparison of extraction methods—

A number of crude oils were extracted according to the evolved procedure, and these results were compared with those obtained by extracting according to the U.O.P. Method, Procedure A. The titration procedure, using dichlorofluorescein, was the same in both cases.

Chloride Content of Extracts determined by the evolved procedure and by U.O.P. method.

Type of Crude Oil Extracted	U.O.P. Method	Evolved Procedure
Kansas	58	60
West Texas	328	316
88% Coastal, 12% Kansas	86	86
50% West Texas, 44% Coastal, 6% Kansas	195	185
95% Kansas, 5% Coastal	31	32
60% West Texas, 40% Coastal	182	179
60% Coastal, 40% Kansas	37	38

Summary

A method is suggested for the rapid determination of inorganic chlorides in crude oils. It comprises 1) an extraction of the chlorides by means of an ASTM tetraethyl lead extractor, 2) a titration of the total chlorides using dichlorofluorescein as an indicator, and 3) an addition of standard chloride solution to those extracts containing less than 30 pounds of sodium chloride per 1000 barrels. The method makes it possible to run several extrations simultaneously with a minimum amount of attention by the operator and to determine with good accuracy the chloride content of crude oils, regardless of the chloride concentration.

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Soil Pressure Under Foundations

Thorough method needed where complete soil analysis is required

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THE term "unbalanced loading" or "off center loading" in foundation design work means the location of the net center of all the useful and dead loads at a point elsewhere than on a vertical line through the center of gravity of the foundation base or slab.

The net center of all the weights or centroid for an unbalanced system is found as follows:

A north-and-south line through the net centers found by multiplying each weight by its distance from, say, the east edge of the foundation and dividing the sum of all those products by the total of the weights. Then an east-and-west line is found in like manner using, say, the south edge of the foundation as a reference line. The intersection of the north-and-south line and the east-and-west line is at the net center of the loads. Heights of the weight centers need not be considered.

The point of maximum soil pressure is found to be just under the periphery of the base slab on the side or corner where the assumed greatest windage action is combined with the maximum effect of any unbalance of the load.

IN THE design of foundations for refinery vessels and towers, unbalanced loading is frequently not a considerable factor and many design procedures neglect its effects entirely; but for cases in which that factor must be considered or where a complete soil pressure analysis is required a thorough method, such as offered herein by the author, must be used.

This point is referred to as the toe and the pressure on the soil there is called the toe pressure. Unit pressure is pressure per unit of area—usually pounds per square foot.

Under any foundation the unit soil pressure results from a combination of factors A, B and C described below. The sum of these is the unit soil pressure at the toe.

A) Combined weight of foundation, backfill, vessels and useful or test load. This causes a unit soil pressure at all points, of: Total weight divided by total area of the base.

B) Overturning effect of the wind, this causes a unit pressure at the toe of: Wind moment divided by section modulus of the base area.

C) Overturning effect of unbalance of load. This causes a unit pressure at the toe as follows: Gross weight x distance of net center of load from center of gravity of base area x distance of toe from center of gravity of base area; all divided by moment of inertia of the base area.

If the total weight is balanced about or is centered on a vertical axis through center of gravity of the base, then factor C is zero and the other two determine the maximum soil pressure.

The magnitude of the allowable unit soil pressure is based on accepted de-

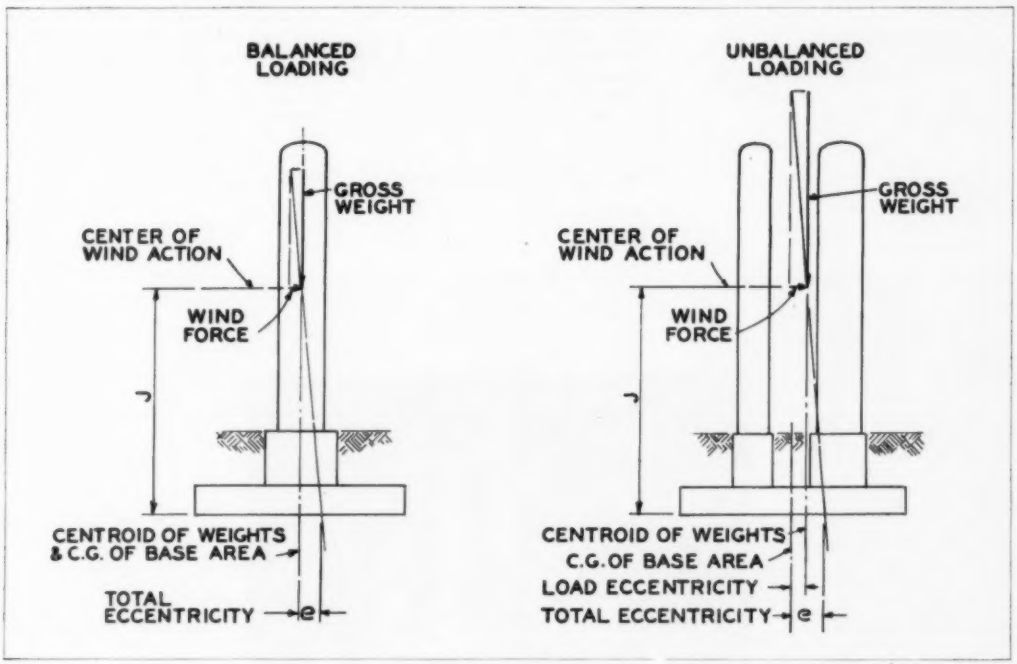

Figure 1. Graphical Solutions for Eccentricity.

sign practice and on field conditions and will not be discussed here. Also no consideration will be given here to the design of foundations to be poured on bedrock.

Calculation of Eccentricity

The term eccentricity as used here means the distance, along the under side of the foundation base slab, from the center of gravity of that area to the point of action of the combined weights, loads and overturning forces. It is vital that this distance be no more than a certain fraction of the distance across the base. (See allowable eccentricities below). If that proportion is exceeded, the foundation will be unstable and not efficiently designed to resist overturning forces. That is because under maximum overturning conditions a portion of the soil under the heel of the foundation will be carrying none of the weight, leaving an excessive amount for the toe area to carry.

For a given set of conditions eccentricity, e, equals overturning moment of wind plus overturning moment caused by unbalanced load, all divided by total weight, or

$$e = \frac{(F_w \times J) + (W_v + W_c)e_c}{W_v + W_c} = \frac{F_w \times J}{W_v + W_c} + e_c$$

Where

e = eccentricity.

e_c = distance from c.g. of base to centroid of combined weights (This is zero for symmetrial systems).

F_w = wind force.

J = Distance from center of wind force to bottom of foundation.

W_v = Weight of vessels (test for both full and empty vessels).

W_c = Weight of concrete foundation.

Allowable Eccentricities

Allowable maximum values of eccentricity for various shaped foundation bases are as given below. Where two figures are given the smaller one should normally be used because windage force may occur in any direction.

Circle—.125 x diameter.

Square—.118 or .167 x width (for eccentricity toward corner or side, respectively.

Rectangle—.167 x width or .167 x length (for eccentricity toward side or end respectively).

Hexagon—.120 or .139 x distance across flats (for eccentricity toward corner or side respectively).

Octagon—.122 or .132 x distance across flats (for eccentricity toward corner or side respectively).

Note that for the common shapes listed here the permissible eccentricity is less if toward a corner of the slab than if toward a flat side.

Graphical Solution for Eccentricity

The accompanying diagrams will illustrate the solution for eccentricity by graphical methods. The same general procedure is used whether for balanced or unbalanced systems.

The foundation width across flats (or diameter if round) is laid out to any convenient (large) scale. The distance from the bottom of the slab to the center of action of the wind, distance J, is shown using the same scale. If the loading is unbalanced the centroid of weights is found as described above and its distance from the center of gravity of the base area is shown to the same scale.

Next, a horizontal vector (arrow) with a length representing the magnitude of the total wind force in pounds is drawn at a height J and so its tip is at the vertical line representing the centroid of the weights. To the same scale as used for the wind vector, a vertical vector representing total weight is drawn along the centroid line so its tip meets the tip of the wind vector. Complete the rectangle which has these two vectors as adjacent sides. Draw the diagonal (resultant) through the intersection of the two arrows and extend it to intersect the bottom of the slab. Scale the distance from this point of intersection to the center of gravity of the foundation. That distance is the eccentricity, e, of the system. Find the proportion of e to the width of the foundation and compare with the allowable eccentricity for the shape of foundation slab being designed. If e does not exceed the limits given, the slab is broad enough for the conditions at hand.

These general principles may be applied to any case of symmetrical or non symmetrical loading or to odd shaped foundation slabs. The center of gravity of an odd shape may be found by methods described in handbooks. Also therein may be found the moments of inertia and section moduli of various shapes. For simplicity and by using conservative values, the allowable eccentricity for irregular shaped slabs may be assumed to correspond to those of the nearest regular shapes and designs may be made and checked accordingly.

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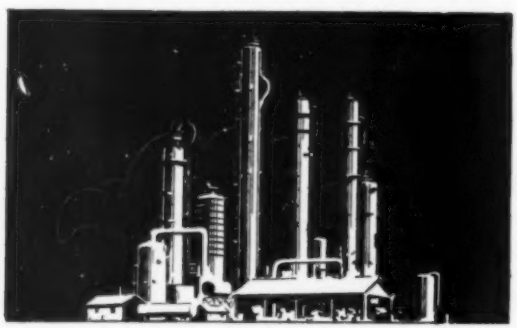

Holland Gets New Petrochemical Plant

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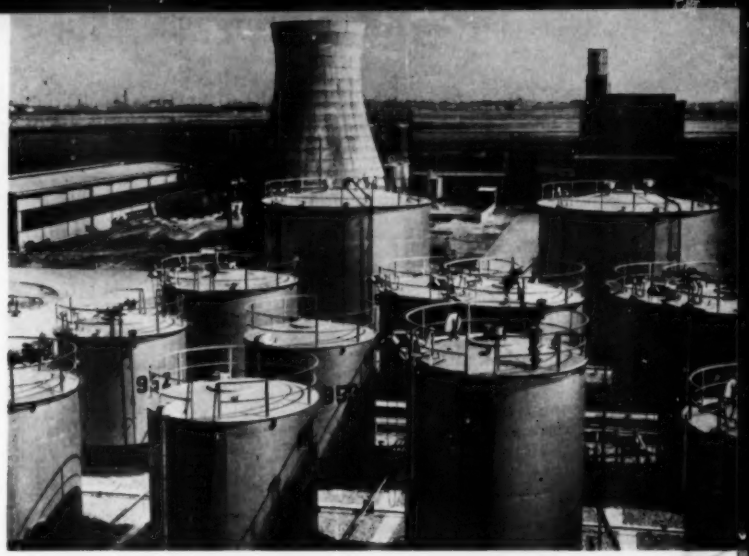
Consultant, London



A view of Shell's petrochemical plant recently opened at Pernis, Rotterdam, Holland. This photo was taken from the tank storage of the ester salts plant (foreground). At right background can be seen the powder preparation building with part of the Kestner evaporator visible on top. Behind the concrete cooling tower are the four vinylchloride monomer storage tanks and, in the background, the tanks for dichloroethane base material, slops and auxiliary materials.

A NEW source of petroleum-based chemicals was recently made available to Holland, when the chemical plant erected at Pernis, Rotterdam, was opened by Bataafsche Petroleum Maatschappij, an operating company of the Royal Dutch-Shell group. It forms part of the group's 170 million guilder (£16 million sterling) postwar construction program.

One section of the chemical plant will produce synthetic detergents and the other, plastics.

Production from the new Pernis installations also marks a further stage in the Royal Dutch-Shell group's program of expansion in the petrochemical field, one in which the group has pioneered since 1930. Large plants in the United States are already producing important chemicals, including synthetic glycerine and industrial alcohol; while in the United Kingdom the Stanlow installation, recently opened, is manufacturing solvents that, at present, can only be purchased in the U. S.

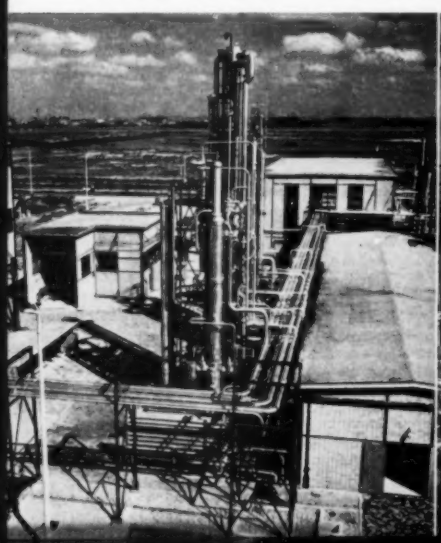
At Pernis, Shell's nearby Rotterdam refinery will be able to provide all the raw materials required when the present refinery expansion program is completed by 1952. The proposed extensions include a distillation unit of about 42,000 barrels daily intake, a high-vacuum installation, a catalytic cracking unit of about 2000 barrels daily capacity and a reforming unit. Tankage capacity, which is now 4.9 million barrels, is being increased to 7.71 million. Ultimately the labor force for both refinery and chemical plant will total 2600.

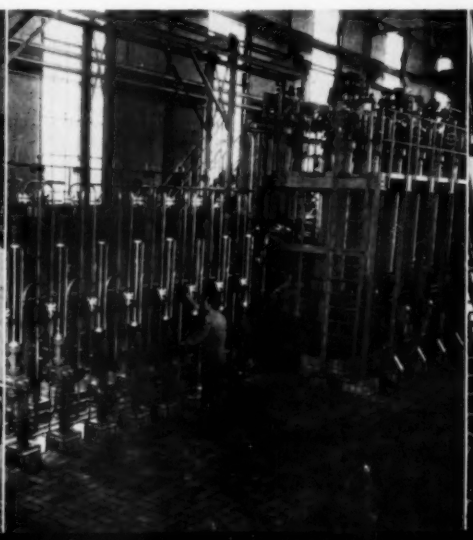
In the detergents section the base material used is paraffin wax. After cracking and chemical treatment a liquid is finally obtained which can be used as a detergent or which can be evaporated to form flakes or powder. The resulting product has many advantages over ordinary soap.

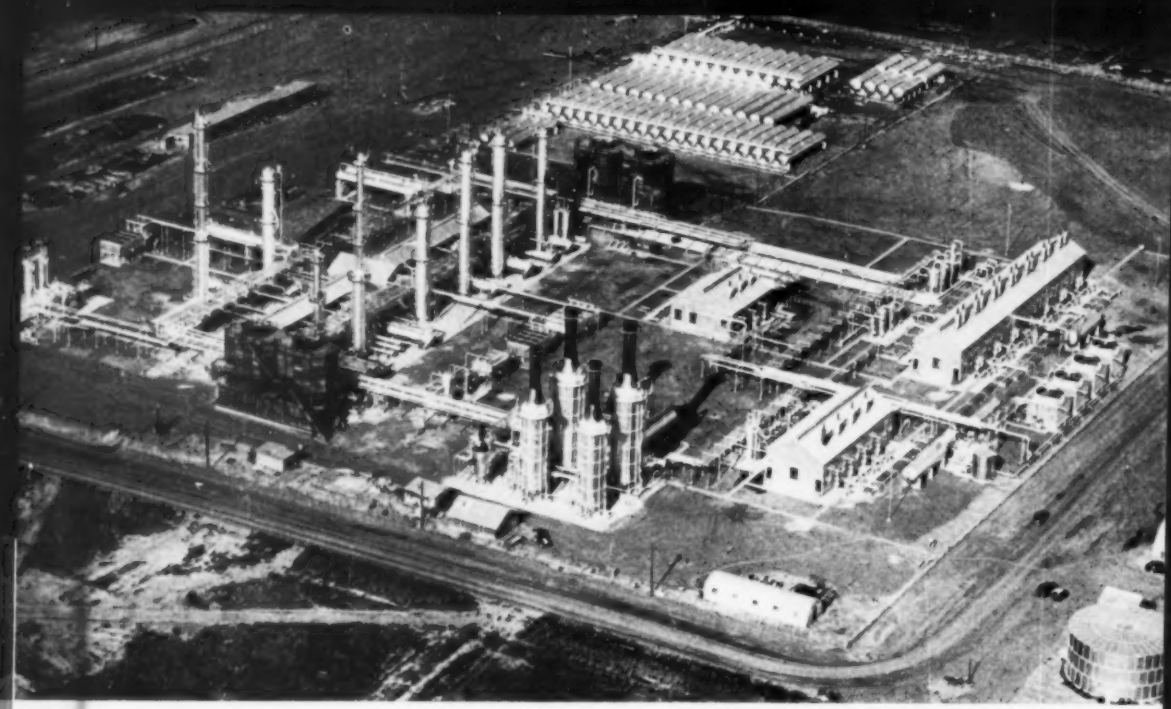
In the manufacture of plastics (polyvinyl chloride synthetic resins) the base materials are cracked gas and chlorine. (The cracked gas is obtained elsewhere, pending completion of the refinery extension). By applying pressure and heat polyvinyl chloride, which belongs to the group of thermoplastics, can be moulded into sheets, plates, tubes, etc. It has great resistance to acids and alkalis.

Special metallic alloys are used at Pernis in the pipe lines, pumps, and tanks, because of the corrosive nature of the materials processed. Also, the high standard of purity, which the intermediate and final products have to satisfy, has called for numerous provisions against contamination.

The three photos below show views of Shell's plant at Pernis. Panel on left — Distillation columns and pumphouse for the purification of the dichloroethane and processing of the product of the crude pyrolysis reaction. Inhibitor, emulsifier and catalyst solutions are prepared in the small building at left; larger building at rear is polymerization unit. Center Panel — Interior view of polymerization unit where, by separating the residual monomer from the polymer suspension, the final polyvinylchloride plastic is formed. Right Panel — Part of the maze of pipe lines for the pumphouse and distillation unit of the polyvinylchloride plant. In columns at rear, the purification of the dichloroethane and processing of the product of the crude pyrolysis reaction is carried out.







This aerial view of the Maysville unit shows the induced draft cooling towers and the direct-fired oil furnaces in the foreground, the distillation and fractionation equipment at the left and the compressor building and auxiliary equipment at the right, and the plant storage for natural gasoline and liquefied petroleum gas in the background.

Unusual Gasoline Plant System Serves Six Oklahoma Pools

A joint natural gas conservation venture by five companies has resulted in "The Garvin County Plants" in the Golden Trend Area of Oklahoma. The unusual plant system will process gas from six pools—Antioch, Elmore, Lindsay, Maysville, New Hope, and Wayne.

The new plant system consists of a large central plant at Maysville and two remote compression and absorption plants, one at Antioch and the other at Lindsay; however, the three plants operate as one major unit to process in excess of 80 million cubic feet daily of gas for a liquid product recovery exceeding 300,000 gallons daily. This system was utilized since several of the pools served are not large enough to support independently a natural gas processing plant. Companies participating in the project are The Carter Oil Company, Cities Service Oil Company, The Texas Company, J. E. Crosbie, Inc., and Warren Petroleum Corporation. Supervision of construction and operation of the plant is by Warren.

Operation of the unit is achieved by continuous circulation of the absorption oil between the Antioch and Maysville plants, about 7½ miles, and between the Lindsay and Maysville plants, also about 7½ miles. Rich absorption oil from the Antioch and Lindsay plants is commingled with the rich absorption oil from the absorption section of the Maysville plant for processing through the distillation section, which is at the Maysville plant.

Water is scarce in the immediate vicinity, a problem which was solved by piping 10,000 barrels daily of water from four wells drilled about 17 miles from the Maysville plant. The water supply problem was responsible to some extent for several features of the project including direct-fired oil heaters for the two distillation stills, all fractionator reboiler heating, and other schemes to eliminate steam boilers. Two furnace units heat rich oil charged to the stills from 380° to 525° F. There are two similar units to supply primary heat to a continuously circulated heating oil stream for all plant heat requirements above the conventional exchange recovery from the still base hot lean oil. Radiator type coolers cool the engine jacket cooling water, and the still and debutanizer primary condensers. This method insures a minimum cooling water loss.

The Antioch plant's 13 compressors (8400 horsepower) compress gas from five inches vacuum to 760 pounds absorber pressure. Design volume is 31 million cubic feet of gas daily. This plant contains a dehydration unit of the solid desiccant type, which has a capacity of 30 million cubic feet daily of residue gas. Gas for reservoir injection is compressed to 2400 pounds in three compressors, totaling 2000 horsepower.

There are 10 compressors in the Lindsay plant, nine of which compress 27 million cubic feet daily of gas to 760 pounds for absorption. The tenth compressor boosts 9 million cubic feet daily of gas through one stage from 200 pounds to 760 pounds. This gas is from the portion of the Lindsay field that has separator pressures in excess of 200 pounds. As in the Antioch plant, the Lindsay unit has solid desiccant dehydrators for drying the absorber residue gas, which is sold. Preheated residue gas is used to regenerate the dehydrators.

The Maysville plant consists of compressor and absorber cycles similar to the Antioch and Lindsay units. In addition, however, this plant contains complete distillation, fractionation, storage, and loading facilities for natural gasoline and lpg products.

Two 600-horsepower compressors are used to compress 4.5 million cubic feet of gas daily from five inches vacuum to the absorption pressure of 760 pounds. Two compressors, each of 800-horsepower, compress 9 million cubic feet of gas daily that is available at 40 pounds inlet pressure to 760 pounds. The absorber in the Maysville unit is designed for 30 million cubic feet daily of gas. The Maysville plant features the installation of two parallel units, for both rich oil demethanizing and distillation,

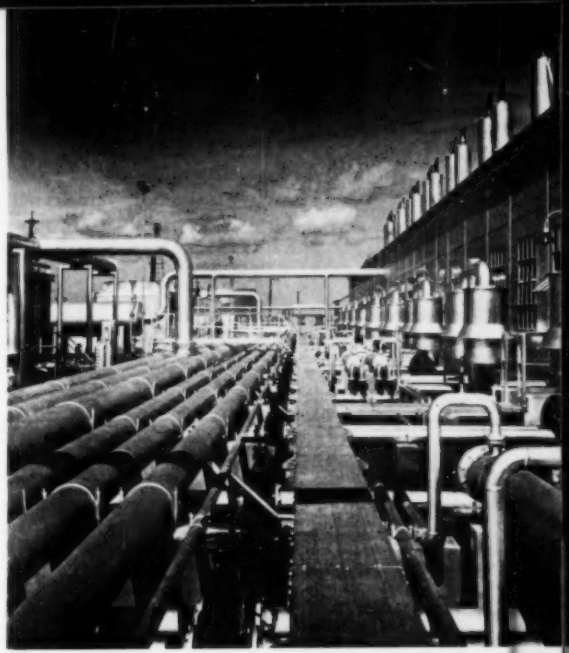
a method which avoids excessive tower diameters, fabricating costs and provides greater operating flexibility.

Rich oil from the three plants is flashed in two parallel-operated feed surge tanks at the Maysville plant. The rich oil is then charged to the top of the stripping sections of the two parallel-operated demethanizers. Stripping heat for the rich oil demethanizers is supplied by exchanging hot lean oil from the still with a base draw-off stream of rich oil from the stripping section, which is returned to the base of the demethanizer towers. Additional base heat is provided by a shell and tube unit heated by hot oil from a direct-fired heating oil furnace.

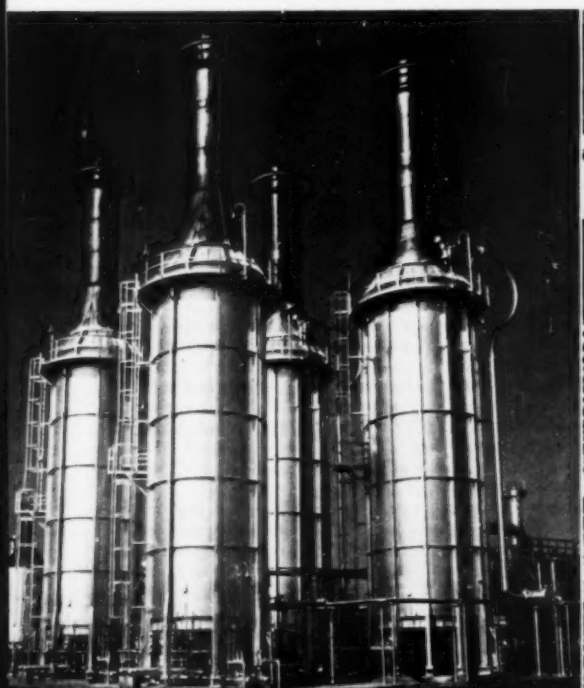
From the base of the demethanizers rich oil flows to the hot flash tanks operated in parallel. From the flash tanks, the temperature of the rich oil is raised from 380 to 525° F. in the direct-fired vertical tube coil furnaces and charged to the parallel operated stills at 90 pounds pressure. Vapors from the hot flash tanks are preheated by hot lean oil from the still base and charged to the stills as primary stripping medium several trays below the rich oil feed. Final stripping of the oil in the stills is accomplished by preheating deethanizer overhead vapors to 500° F. and charging to the stills below the first tray.

Air-cooled type finned coolers are employed for primary condensing of still overhead vapors. Final condensing is done in an induced draft cooling tower. Raw gasoline make-tank vapors at 75 pounds are compressed and coil blended with the liquid hydrocarbon stream from the tank and then charged to two large parallel-operated gasoline surge tanks. Raw gasoline production is dehydrated in solid desiccant type units which permit refrigeration of the deethanizer overhead stream with the result that the commercial propane product from the depropanizer does not require further dehydration.

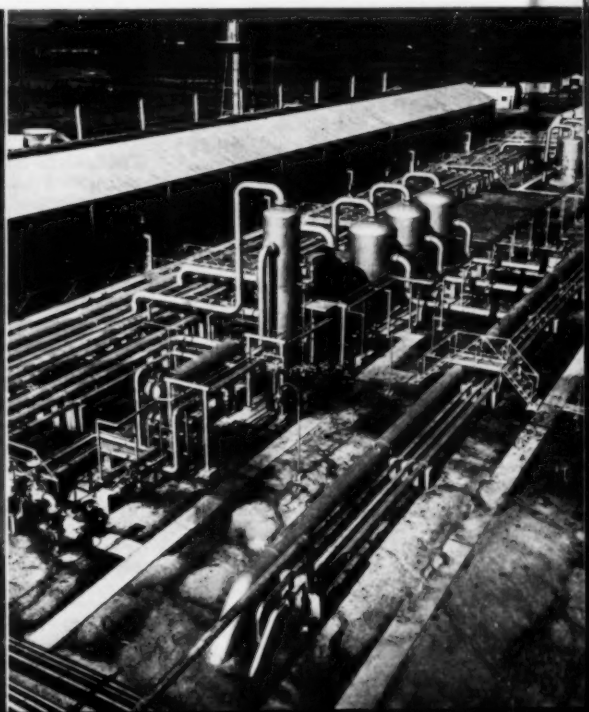
Final fractionation is carried out in a conventional cascade cycle. Vapors from the deethanizer are used for final oil stripping in the stills, and the base product is charged to the depropanizer and the debutanizer for production of propane and butane and natural gasoline.



Inlet gas headers for the compressors in the building at the right at the remote compression and absorption unit near Lindsay, Okla. This unit can handle in excess of 30 million cubic feet of gas daily



These direct-fired oil heaters are used instead of the conventional steam boilers for generating plant heat and processing temperatures. These units are rated at 30 million Btu. per hour.



The Antioch remote compression and absorption unit not only processes gas for distillation and fractionation at the Maysville unit, but also supplies residue gas for repressuring operations in adjacent areas.

Pipe Supports And Pipe Restraints

ROBERT G. BLICK, Sun Valley, California

PIPE *supports* are special cases of a more general category—*pipe restraints*. The factors which determine the piping restraint scheme are weight, temperature, vibration, wind, expansion joint forces, and, occasionally, earthquake. Because these factors often have conflicting solutions, the restraint system is generally a compromise. It should be emphasized that proper *layout* of lines subject to temperature expansion must include the restraint scheme, even if only in a general way. Investigation of any part of the behavior should treat the piping layout and the pipe restraint scheme as an integral unit.

The function of pipe restraint systems is simply to "hold" the piping system in a manner such that failure will not occur. In the design office, the comparison of calculated stresses with allowable stresses is no more than a recognized basis for predicting possible functional failure. In courts of law the "purpose of the legislators" is fundamental in interpreting statutes; in the design of piping systems and piping restraints, the purpose of the various codes should be kept in mind. This is preventing functional failure or danger to life and property. Of several possible systems, one will usually be inherently the less liable to functional failure.

References on standard methods of temperature stress analysis are included in the bibliography. In many complicated cases a simplified system can be substituted which is easier to analyze than the real layout and which will give results on the safe side. Also, some methods in themselves involve simplifications. These simplifications must be applied with caution, however, and it must be definitely established that the results are on the safe side for the *critical* portions of the actual piping system. This is especially important where smaller diameter branches are involved or where certain sections must have low bending-moments or forces. High bending-moments may exist at locations where the substitute case indicates low moments.

Piping comes under several different applications — pump, compressor, tower, drum, heater, etcetera. An attempt is made to define the special problems (and to suggest the solutions) usually encountered in the different applications. Unavoidably, a discussion of pipe restraints becomes also a discussion of piping layout. Certain general principles should always be kept in mind:

(1) Critical piping sections and local stresses can be decisive in the choice of a restraint system.

(2) All restraints make piping less flexible than where no restraints are used.

(3) A system completely "floated" on springs or counterweights is not as inherently safe as a system which includes several points of rigid support.

(4) Reversed forces and moments can occur under "cold" conditions (for high temperature piping), which may be additive with other loads on the structure.

Pump and Compressor Piping

In the consideration of pump and compressor piping restraints, the critical points are the nozzles for both steam and product ends and unreinforced branch connections to headers.

Application of piping flexibility to reduce nozzle moments and forces is difficult to generalize due to the meager information available regarding the strength of nozzles and casings. Most compressor and pump manufacturers stipulate that no piping forces and moments are allowed at nozzles. Actually this is a requirement impossible to meet, and there is real danger of doing more harm than good in devising various types of restraints in an attempt to meet this stipulation. *Computed* stresses (or forces and moments at the nozzle) are not *necessarily* criteria for failure, due to the mitigating effect of minute deformations allowing an approach to pin action at the nozzle. The value of stops and anchors is often debatable in view of the resulting increase in the general stiffness of the system, and the uncertainties in installation, relative settling of equipment foundations, and other variables. If stops or anchors are used, certain "rules of thumb" may be applied:

(1) If the restraint is *not* integral with the equipment foundation, there should be enough flexibility between the nozzle and the restraint to allow any fortuitous deflections between the restraint and the nozzle to occur without setting up excessive moments at the equipment nozzle (for instance, settling of the equipment foundation or deflection of the

***THOUGHTS EXPRESSED** by the author of this article on process plant piping have considerable bearing upon the story proper. In correspondence leading to the publication of this story, Blick states, "It is my personal feeling that supports and restraints (and flexibility) are comparatively simple things—once the general problems and purposes are pointed out and clarified. The remainer of the job is elementary application of the principles of statics and strength of materials, and then the design details of individual restraints."*

"The article is more or less 'graded' in difficulty. Everyone can read the text and get something out of it. A lesser number can understand the charts and tables and use them as a kind of reference point. A smaller number can fully understand all the charts and the mathematics and derive full benefit from them. Actually, no more than elementary calculus is used in even the most 'difficult' part of the mathematics. The latter sessions of the article marked 'Derivations' have probably not been published before—certainly not as applied to pipes—and are therefore something of an original contribution."

"The primary job is that pointing out and clarification of the problems connected with and the methods needed for support and restraint location. It is a sort of collection of suggestions that the designer can use to guide his work."

structure under load).

(2) If the restraint is integral with the equipment foundation, such as on a concrete bracket or shelf cast integrally with the equipment block, it should be as close as possible to the equipment. The vertical and lateral expansion between the anchor and the equipment should not deform the casing. The lateral expansion can often be accommodated with sufficient clearance around the anchor bolts. These so-called "base anchors," capable of withstanding moment, are preferable to other restraints for the reason that the general stiffness of the piping system is not increased. Full advantage is taken of the vertical run.

Use of Expansion Joints

Expansion joints are used chiefly for large lines at reciprocating compressors and pumps. Sometimes they are used for centrifugal equipment. Their purpose is twofold: 1) vibration strains which otherwise would be imposed on the equipment nozzle by the heavy mass of large piping are eliminated, and 2) expansion stresses are kept from the nozzles. The use of expansion joints is more or less standard for certain types of equipment. The equipment manufacturer will frequently specify the use of joints where they have been found necessary. Expansion joints must be guided on each side, and the ends must be anchored to take hydrostatic thrust. In the case of expansion joints connecting directly to equipment nozzles, a base anchor or a base elbow must be used, and an adequate pedestal provided to take the thrusts.

Weight stresses are kept off equipment nozzles in three ways. Base supports and base anchors can be used for hot or cold piping. Spring hangers or spring supports can be used for hot piping in locations where there is vertical movement. Rod hangers or structural supports can be used for cold piping, or for hot piping where there is no vertical movement or the resulting restraint is tolerable.

Vibration stresses may be kept low by keeping the mass and moment arms of the piping low. Design for expansion flexibility, and low vibration of piping, are opposed considerations. The design must allow for both. Anchors, stops, and guides are used to prevent excessive vibration of piping at reciprocating compressors and pumps. These restraints must not interfere with the flexibility and expansion movement of the piping. Frequently the restraints used to keep expansion stresses from nozzles may also act to dampen vibration of the piping by judicious choice of location. In cases where the pump or compressor itself vibrates, the restraint will attempt to hold down the equipment via the pipe and nozzle and severe stresses may be set up. To prevent this, the design and location of the restraint should allow for sufficient piping flexibility between the nozzle and the restraint.

Tower and Drum Piping

In tower and drum piping the critical points are the tower shell at the nozzle and the piping itself.

Flexibility to accommodate expansion may be obtained by arranging the equipment locations and nozzle orientations so that the natural run of the pipe will be sufficient. Otherwise, expansion loops must be used. For computing stresses the worst conditions should be considered—the line hot and the tower cold, vice versa, or both hot—unless the line and tower can be considered to change temperature simultaneously. Start-up conditions must also be considered.

Trouble is encountered from vertical expansions in four cases: control station piping at towers, cold piping connected to hot towers (and vice versa), closed relief system piping, and piping between adjacent towers and equipment.

Trouble is encountered from horizontal expansions in three cases: piping between remote towers and equipment, closed relief system piping, and hot oil transfer lines.

When expansion joints are used, substantial anchors and guides are required. Standard expansion joints must be subject to axial deformation only. Special joints, or special combinations of standard joints, have been used to accommodate lateral offset or cocking. In all cases where expansion joints are used, the thrusts must be provided for, and any local shell stresses checked (unless the thrust is in a direct line with the nozzle).

The dead weight of piping can be carried by the nozzles or by brackets. Frequently the shell stresses set up by the brackets can be worse than if the load were carried by the nozzles directly. When brackets are welded to hot towers, the stresses set up in the brackets and in the shell locally due to the expansion should be investigated, besides the check for weight stresses.

In computing required spring hanger *flexibility*, the worst condition (line hot and tower cold, vice versa, or both hot) should be considered. *Set heights* are determined, of course, by the normal operating conditions. Control stations and heavy valving should preferably be located so as not to require spring supports, or to require a minimum number. "Kinks" and offsets in vertical runs of pipe should be avoided, most of all directly below the point of support.

In determining heater and furnace piping restraints, the critical points are the heater header, tubes, piping and termination of piping at other equipment (such as a tower nozzle).

Fired Heater Piping and Anchors

When piping flexibility is used to accommodate temperature expansion at horizontal tube heaters, natural changes in direction should be used to keep stresses low wherever possible. Depending on the strength characteristics of the heater tubes and header, an anchor at the heater may or may not be necessary. Large diameter lines usually require an anchor. This anchor should be located at or near the center line of the heater, to equalize the expansion of the heater tubes. This can be done by locating the heater nozzle at the far side of the heater, so that the pipe will cross the heater center line in its path to the served equipment. With some heaters it is possible to force the expansion of the tubes in one direction, and an anchor is used directly at the heater nozzle.

At vertical tube heaters, if the piping from heater to equipment is sufficiently flexible and there is no great size reduction at the heater nozzle, usually no anchors will be required at the heater. Where the piping is stiff and of considerably larger diameter than the tubes (for instance where the heater is used as a reboiler) an anchor at the heater will be necessary to protct the heater tubes and nozzle. This anchor is preferably located at approximately the same elevation as the bed of the heater to avoid differential vertical expansion. Horizontal expansion from the heater nozzle to the anchor is usually small enough not to require special consideration. Large lines will usually require this anchor to be separate from the heater steel, or the heater steel must be investigated for the additional stresses. Smaller lines can usually be anchored from the heater steel directly.

The interconnected piping at vertical tube heaters should be made flexible enough between the heater and point of support to take any differential vertical expansions, so that a rigid type support can be used. Relief system piping, and other colder lines connecting to hot lines, should preferably make connection at approximately the same elevation as the bed of the heater, or the pipe support bent. The supporting of lines at vertical tube heaters is especially difficult when the heaters are

remote from any structures. Pipe support bents should be provided close to the heater to carry the weight of the piping and control stations, the pipe support bent being located at approximately the bed elevation.

When expansion joints are used at horizontal tube heaters, an anchor should be provided to take the thrusts, the same as when piping flexibility accommodates the expansion. In addition, guides about the joint and often another anchor at the equipment end will be necessary. Usually, expansion joints are not necessary for piping at vertical tube heaters.

Exchanger Piping

The critical points in exchanger piping are the piping itself, the exchanger shell at nozzles, and flanged joints.

Temperature expansion can usually be provided for by the use of piping flexibility without much complication. Temperature expansion at exchanger bypass piping, inter-connected piping, and cross connections at stacked and paralleled exchangers should be investigated.

Supports for the dead weight of piping can be provided for from the structure, floor or exchanger shell. The layout of control stations and heavy valving should be arranged so that spring supports will not be necessary.

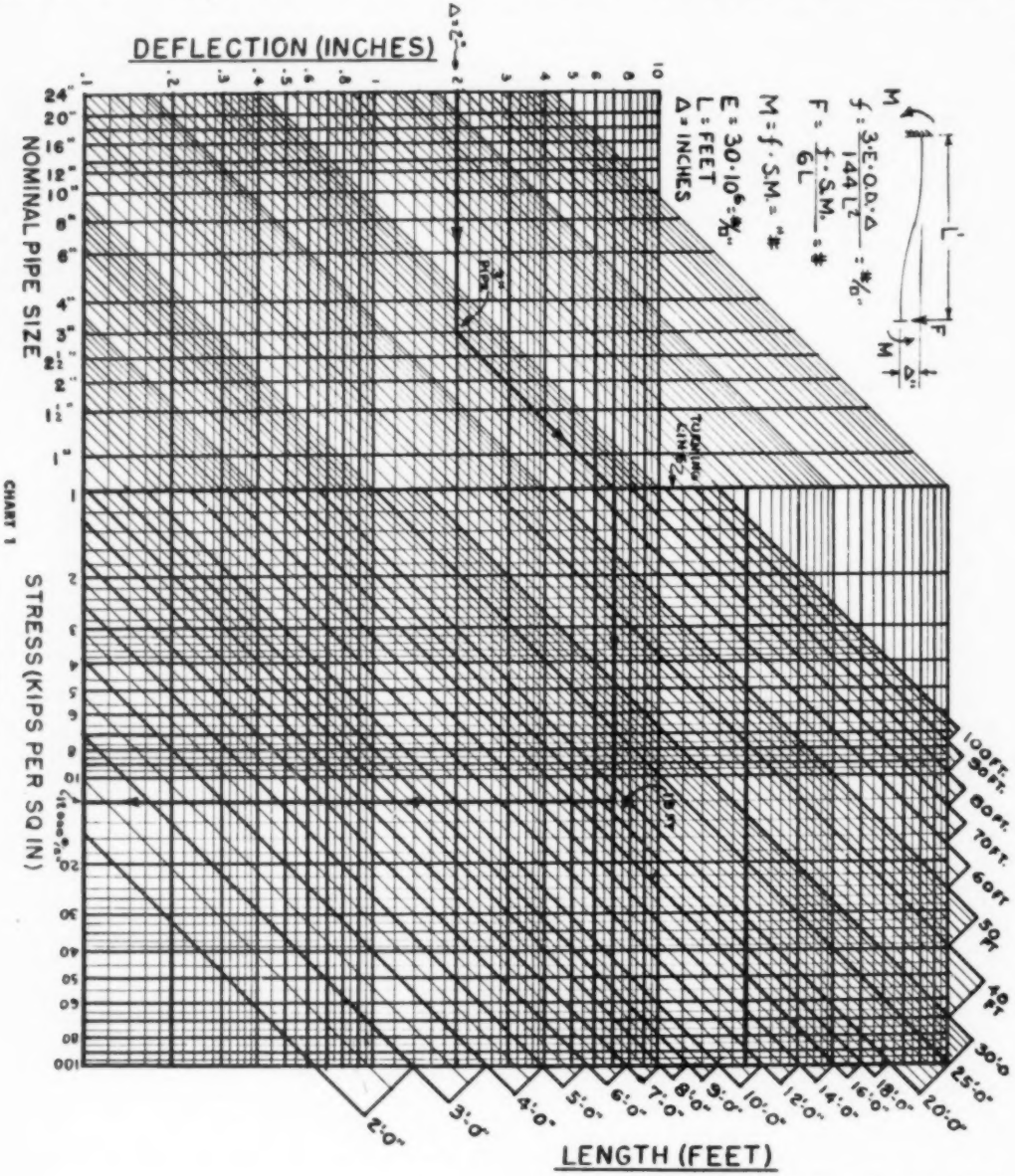
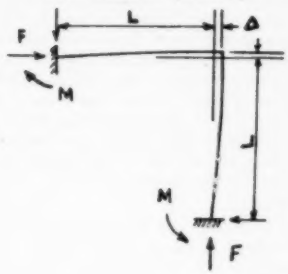


CHART 1

If the horizontal run of the "top" piping to the exchanger nozzle is long enough to take the differential vertical expansion, base supports can be used at the lower piping.

With Table 1 (Below)



Yard Piping

In the consideration of yard piping restraints, the critical points are the lines themselves, branches, and welded branch intersections.

In large yards, the temperature expansion stresses of the large hot headers are seldom high. Anchors, when used, are chiefly useful to establish reference points so that branch line flexibilities can be determined properly. These anchors should be placed judiciously so that neither inordinate flexibility in the branch lines, nor ungainly expansion loops in the headers, are required. Generally it is preferable to make the branch lines more flexible rather than to install expansion loops (or expansion joints) in the header.

The "customer's connection" will frequently determine an anchor location at or near the battery limit. If data on the run of the lines outside the battery limit are available, frequently it is advantageous to eliminate anchorage at the battery limit.

The dead weight is, of course, carried on properly spaced support bents.

$$F = \frac{f \cdot \text{sect. mod.}}{6\,L} = \text{pounds}$$

$$M = f \cdot \text{sect. mod.} = \text{inch pounds}$$

$$E = \text{psi.}$$

$$f = \frac{3 \cdot E \cdot \text{dia.(o.d.)} \cdot \Delta}{144\,L^2} = \text{psi. (L feet, } \Delta = \text{inches)}$$

TABLE 1

Upper figure for each block is the (minimum) length in feet (except where marked " for inches.)
Lower figure is the end force in kips (except where marked # for pounds) for Schedule No. 40 pipe.
Installation temperature assumed is 70° F.

T. °F.	Exp—in./10 Ft. Ex 10^{-6}	Stress	1"	1½"	2"	2½"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"
200	.102	18,000	5.30"	7.56"	9.50"	11.50"	1.17'	1.50'	2.21'	2.88'	3.59'	4.25'	4.67'	5.33'	6.00'	6.67'	8.00'
	28.20		910#	1.55 K.	2.14 K.	3.32 K.	4.42 K.	6.43 K.	11.6 K.	17.6 K.	25.0 K.	33.3 K.	39.5 K.	51.3 K.	65.3 K.	72.0 K.	107 K.
250	.144	18,000	7.32"	10.5"	1.09'	1.32'	1.61'	2.07'	3.05'	3.97'	4.95'	5.88'	6.44'	7.36'	8.30'	9.20'	11.1'
	27.90		655#	1.12 K.	1.55 K.	2.42 K.	3.22 K.	4.66 K.	8.40 K.	12.8 K.	18.1 K.	24.1 K.	28.6 K.	37.3 K.	47.2 K.	52.1 K.	77.0 K.
300	.186	18,000	9.36"	1.13'	1.41'	1.70'	2.08'	2.67'	3.93'	5.10'	6.37'	7.57'	8.30'	9.50'	10.7'	11.8'	14.2'
	27.55		512#	862#	1.20 K.	1.88 K.	2.49 K.	3.61 K.	6.50 K.	9.92 K.	14.1 K.	18.7 K.	22.2 K.	28.9 K.	36.8 K.	40.6 K.	60.0 K.
350	.230	18,000	11.40"	1.38'	1.72'	2.05'	2.54'	3.26'	4.80'	6.26'	7.80'	9.25'	10.1'	11.6'	13.1'	14.5'	17.4'
	27.25		420#	706#	980#	1.53 K.	2.04 K.	2.96 K.	5.33 K.	8.10 K.	11.5 K.	15.3 K.	18.3 K.	23.7 K.	29.9 K.	33.1 K.	49.2 K.
400	.275	18,000	1.12'	1.62'	2.03'	2.46'	3.00'	3.85'	5.67'	7.40'	9.20'	10.0'	12.0'	13.7'	15.4'	17.1'	20.5'
	26.95		357#	603#	830#	1.30 K.	1.73 K.	2.50 K.	4.51 K.	6.85 K.	9.77 K.	14.2 K.	15.4 K.	20.0 K.	25.4 K.	28.1 K.	41.7 K.
450	.321	18,000	1.31'	1.88'	2.36'	2.85'	3.48'	4.47'	6.57'	8.56'	10.7'	12.6'	13.9'	15.9'	17.8'	19.8'	23'8'
	26.65		305#	520#	715#	1.12 K.	1.49 K.	2.16 K.	3.90 K.	5.92 K.	8.42 K.	11.3 K.	13.8 K.	17.3 K.	22.0 K.	24.2 K.	36.0 K.
500	.369	18,000	1.48'	2.13'	2.68'	3.23'	3.95'	5.07'	7.45'	9.70'	12.1'	14.4'	15.8'	18.0'	20.3'	22.5'	27.0'
	26.35		270#	458#	632#	985#	1.31 K.	1.90 K.	3.44 K.	5.23 K.	7.42 K.	9.83 K.	11.6 K.	15.2 K.	19.4 K.	21.4K.	31.7 K.
550	.420	18,000	1.67'	2.40'	3.01'	3.65'	4.44'	5.70'	8.40'	10.9'	13.6'	16.1'	17.7'	20.2'	22.7'	25.3'	30.4'
	26.05		240#	406#	562#	873#	1.17 K.	1.70 K.	3.05 K.	4.65 K.	6.60 K.	8.80 K.	10.4 K.	13.6 K.	17.3 K.	19.0 K.	28.2 K.
600	.471	18,000	1.84'	2.66'	3.32'	4.02'	4.90'	6.30'	9.27'	12.1'	15.0'	17.8'	19.6'	22.4'	25.2'	28.0'	33.6'
	25.75		217#	366#	510#	790#	1.06 K.	1.53 K.	2.76 K.	4.19 K.	6.00 K.	7.95 K.	9.40 K.	12.2 K.	15.7 K.	17.2 K.	25.5 K.
650	.524	18,000	2.02'	2.93'	3.66'	4.43'	5.40'	6.95'	10.2'	13.3'	16.6'	19.6'	21.6'	24.6'	27.8'	30.9'	37.0'
	25.40		198#	333#	463#	720#	960#	1.39 K.	2.51 K.	3.80 K.	5.41 K.	7.22 K.	8.55 K.	11.2 K.	14.1 K.	15.6 K.	23.2 K.
700	.578	17,600	2.24'	3.25'	4.06'	4.90'	6.00'	7.66'	11.3'	14.7'	18.3'	21.7'	23.8'	27.2'	30.6'	34.1'	40.9'
	24.90		178#	300#	417#	650#	853#	1.26 K.	2.26 K.	3.45 K.	4.91 K.	6.51 K.	7.76 K.	10.1 K.	12.8 K.	14.1 K.	21.0 K.
750	.633	17,200	2.44'	3.53'	4.42'	5.33'	6.50'	8.36'	12.3'	16.0'	20.0'	23.6'	26.0'	29.7'	33.9'	37.0'	44.5'
	24.30		166#	276#	383#	596#	797#	1.16 K.	2.08 K.	3.17 K.	4.50 K.	6.00 K.	7.10 K.	9.25 K.	11.6 K.	13.0 K.	19.3 K.
800	.688	16,500	2.68'	3.87'	4.85'	5.86'	7.14'	9.17'	13.5'	17.5'	21.9'	26.0'	28.5'	32.6'	36.7'	40.7'	48.9'
	23.45		149#	252#	349#	544#	724#	1.06 K.	1.90 K.	2.88 K.	4.10 K.	5.45 K.	6.46 K.	8.42 K.	10.7 K.	11.8 K.	17.6 K.
850	.742	15,400	2.96'	4.27'	5.35'	6.47'	7.88'	10.1'	14.9'	19.4'	24.2'	28.7'	31.5'	36.0'	40.5'	44.9'	53.9'
	22.30		135#	228#	316#	493#	658#	956#	1.72 K.	2.61 K.	3.71 K.	4.93 K.	5.85 K.	7.63 K.	9.70 K.	10.7 K.	15.9 K.
900	.798	14,200	3.22'	4.65'	5.82'	7.05'	8.60'	11.0'	16.2'	21.2'	26.3'	31.2'	34.3'	39.2'	44.1'	49.0'	58.8'
	20.85		124#	210#	290#	452#	602#	878#	1.58 K.	2.39 K.	3.42 K.	4.53 K.	5.38 K.	7.00 K.	8.89 K.	9.77 K.	14.6 K.
950	.855	12,600	3.60'	5.20'	6.50'	7.90'	9.60'	12.3'	18.2'	23.6'	29.5'	34.9'	38.3'	43.8'	49.3'	54.7'	65.7'
	19.40		111#	187#	260#	403#	540#	785#	1.40 K.	2.15 K.	3.05 K.	4.06 K.	4.82 K.	6.28 K.	7.95 K.	8.77 K.	13.0 K.
1000	.912	10,900	4.13'	5.95'	7.46'	9.02'	11.0'	14.1'	20.8'	27.0'	33.8'	40.1'	45.0'	50.3'	56.7'	63.0'	75.5'
	18.00		97#	164#	227#	353#	470#	685#	1.23 K.	1.88 K.	2.66 K.	3.53 K.	4.10 K.	5.44 K.	6.90 K.	7.60 K.	11.4 K.

Special Methods

It is possible to formulate rules for general piping restraint and flexibility problems, but it is extremely difficult to make these rules specific enough to cover every case. In each case, the broader aspects of the problem should be kept in mind. It should not be necessary to make detailed analyses of every piping and pipe restraint problem. Utilization of simple relationships is frequently all that is necessary for the adequate solution of temperature expansion and pipe restraint problems. Use of guided-cantilever charts to choose the location of a rigid support, or to determine the length of a "leg" to take expansion, is an example of this simplification. Even in cases subsequently requiring detailed analysis, a preliminary simplified study helps to prevent major errors.

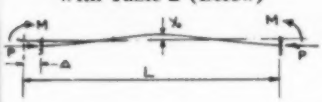
Chart 1 is published for a dual purpose: it is of help to the designer who is somewhat hazy on temperature expansion analysis, and it is a valuable adjunct to moment distribution methods of computing stresses. It is not generally appreciated how valuable moment distribution methods are for simpler types of temperature expansion problems. In the two sample calculations, fixed end *stresses* are directly balanced. In more complicated problems it is best to make a preliminary estimate of the sidesway. The method can, of course, be applied to piping in more than one plane. However, the balancing process becomes quite involved.

The Equal-Leg Bend

Table 1 shows the minimum dimensions required in an "equal-leg" layout for various pipe sizes and temperatures. It is helpful in the preliminary setting of equipment locations. The table should help dispel the misconception held by some designers that an equal-leg layout is invariably capable of "absorbing" its own expansion. The table assumes that allowable stress is as indicated, that installation temperature is 70° F., and no credit has been taken for the direct and shear deformation.

Examination of the table shows that the end reactions increase as the length of the leg decreases. For very short lengths the reactions are apparently tremendous. However, in any practical case where the amount of expansion to be accommodated is small, the end fixation may be sufficiently "limber" so that neither large forces nor large stresses are realized. Given only a small amount of rotational freedom at the end points, there will be considerable diminution of the forces and stresses; complete rotational freedom diminishing these to a quarter, and a half, respectively. If a short run is piped into the side of a thin-walled vessel, for example, a force or bending moment of reasonably small magnitude may produce sufficient local deformation, both direct and

With Table 2 (Below)



Line will not bow if $L \leq \frac{\pi R}{12}\sqrt{\frac{2}{\varepsilon T}} = L_{max}$

Line will bow if $L > \frac{\pi R}{12}\sqrt{\frac{2}{\varepsilon T}}$

$f = E\varepsilon T$ when line is not bowed

$f = \frac{Py_o}{SM} + \frac{P}{A}$ when line is bowed

$Y_o \approx R\sqrt{\frac{144\,\varepsilon T L^2}{\pi^2 R^2} - 2}$

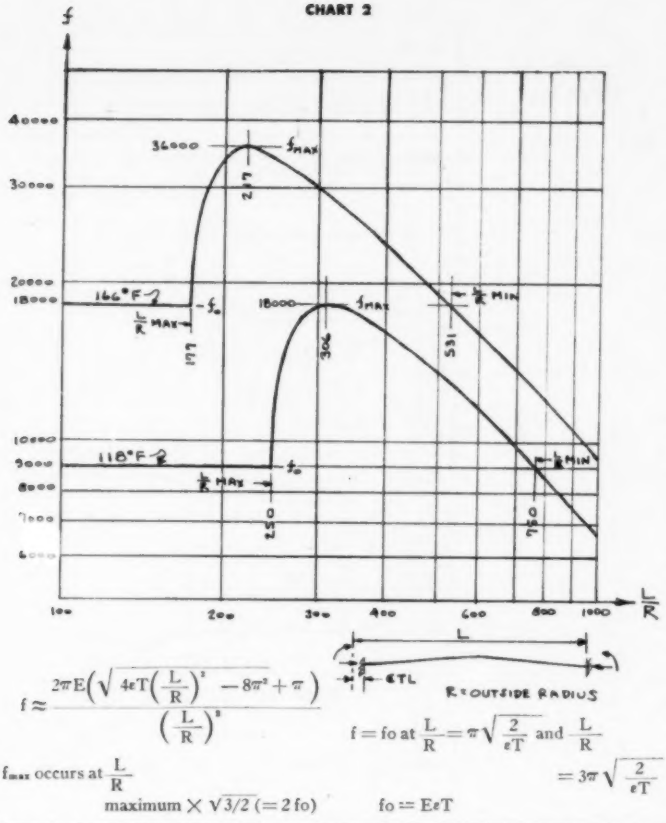
$P = \frac{4\pi^2 EI}{144L^2}$

L_{min} = minimum length, when line bows, to experience no overstress. (Longer lengths will have lower stress.)

I = moment of inertia
R = outside radius
L = length (feet)
SM = section modulus
f = stress
A = area
M = Py_o
ε = expansion coefficient
T = amount increase in temperature
T° F. = T + 70° F. (operating temperature

TABLE 2

T °F. STRESS	SIZE → / Value ↓	1"	1½"	2"	2½"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"
100 °F. 5620 psi	L Max.	17.4 Ft.	25.0	31.3	38.0	46.2	59.2	87.5	114.0	142	168	185	211	238	264	317 Ft.
	△	.041 In.	.059	.074	0.09	.109	.140	.207	.269	.34	.40	.44	.50	.56	.62	.75 In.
	P	2760#	4500	6000	9600	12.5K	17.8	31.3	47.2	67	88	102	136	173	203	283K
118 °F. 9000 psi	L Max.	13.7 Ft.	19.8	24.8	30.0	36.5	47.0	69.0	90.0	112	133	146	167	188	209	250 Ft.
	△	.052 In.	.075	.094	.114	.138	.178	.261	.340	.42	.50	.55	.63	.71	.79	.95 In.
	P	4400#	7200#	9800	15.4K	20.0	28.5	50.0	75.5	107	141	163	218	277	325	455K
166 °F. 18000 psi	L Max.	9.70 Ft.	15.0	17.5	21.2	25.9	33.2	48.9	63.6	79	94	104	118	133	148	177 Ft.
	△	.074 In.	.114	.134	.162	.197	.254	.374	.485	.60	.72	.79	.90	1.0	1.1	1.4 In.
	P	8800#	14.4K	19.2	30.8	40.0	57.0	100	151	214	282	327	435	553	650	907K
166 °F. 18000 psi	L Min.	29.1 Ft.	45.0	52.5	63.5	77.6	99.6	147	190	238	282	312	354	399	444	531 Ft.
	△	.222 In.	.342	.402	.486	.591	.762	1.12	1.46	1.8	2.2	2.4	2.7	3.1	3.4	4.1 In.
	P	805#	1200	1880	2960	3910	5700	10.2K	15.7	22	30	34	46	58	68	95K
	Yo	2.63 In.	3.80	4.75	5.75	7.00	9.00	13.2	17.2	22	26	28	32	36	40	48 In.
200 °F. 18000 psi	L Min.	33.0 Ft.	48.0	60.0	73.0	89.0	114	168	219	272	323	355	405	455	505	610 Ft.
	△	.340 In.	.490	.610	.750	.910	1.16	1.72	2.24	2.8	3.3	3.6	4.1	4.7	5.1	6.2 In.
	P	615#	1040	1430	2200	2930	4300	7700	11.7K	16	22	26	34	44	52	71K
	Yo	3.58 In.	5.18	6.48	7.82	9.55	12.3	18.1	23.5	29	36	38	44	49	54	65 In.
250 °F. 18000 psi	L Min.	38.0 Ft.	56	70	84	103	132	194	253	315	373	410	470	528	590	703 Ft.
	△	.550 In.	.810	1.00	1.21	1.48	1.90	2.80	3.64	4.5	5.4	5.9	6.8	7.6	8.5	10 In.
	P	465#	762	1050	1660	2190	3200	5780	8750	12K	17	20	26	33	38	53K
	Yo	5.00 In.	7.26	9.10	11.0	13.4	17.2	25.3	33.0	41	49	54	61	69	77	92 In.



rotational, so that small amounts of expansion can be accommodated, without over-stress of the vessel shell or the piping.

In every practical case of single-plane piping, shear stress can be neglected. For the equal-leg layout, as far as stresses in the *pipe* are concerned, temperature expansion can be ignored up to approximately 229° F. However the effect of the reaction and bending moment at the equipment (nozzle) may require investigation. In the academic case of an equal-leg bend where shear stress governs (when the length of the "leg" divided by the radius of the pipe is less than 2), this upper temperature limit would be approximately 254° F. These values assume an allowable fiber stress of 18,000 psi. and shear stress of 12,000 psi.

Bowing Effect of Long Runs

Long, straight runs of warm or hot piping will bow laterally unless restrained, as they frequently are, by frictional forces or structural restraints. This expansion can be theoretically ignored for a maximum temperature of approximately 118° F., for allowable stresses in the *pipe* of 18,000 psi., for any length of run. In actual practice, the expansion can probably be ignored for higher temperatures, up to approximately 166° F. Once again, the end reaction and bending moment would require investigation. Likewise, the contraction for temperatures down to approximately minus 25° F., for stresses in the *pipe*, could be ignored.

Table 2 has been constructed to show several effects. From 70° F. (taken as installation temperature) to 166° F., the table shows the *maximum* length of run for which there will be *no* bowing effect, and also the amount of expansion involved and the approximate end reaction* for schedule No. 40 pipe. For temperatures 166° F. and above the table shows the *minimum* length of run required if the bowing were not restrained and if advantage were to be taken of this bowing effect to absorb expansion. It also shows the amount of the expansion, the end reaction and (half) the amount of the lateral bowing. The writer does not wish to suggest that this method of accommodating expansion be utilized to any major extent;‡ however, there have been cases where long runs of warm piping have been cambered in anticipation of lateral bowing, to predetermine the direction of the bowing.

Between 118° and 166° F. it is possible to experience an overstress, when bowing is not restrained, for certain critical length-over-radius ranges (when the allowable stress is 18,000 psi.) When the pipe line starts to bow (at a deformation equivalent to an Euler column load) the stress will increase. If the direct stress is sufficiently low the line may not be overstressed when it takes its final bowed shape. If the run is made slightly longer the bowing will increase. The Euler load will decrease. However, the amount of bowing, if the length is in the critical range, will have increased to a greater extent than the Euler column load will have decreased. The result may be an overstress. Continued increase in length finally reduces the Euler load sufficiently to reduce the stress, the stress then continues to fall as the length increases.† Chart 2 shows the effect on stress of a change in the length-over-radius ratio, for temperatures of 118° and 166° F.

It is, of course, possible to have a behavior such that the line does not bow like an Euler column, but develops corrugations (local instability). For the temperature range of the table and the thickness-to-radius ranges of commercial pipe, however, this behavior will not be experienced.

Pipe Size Reductions

Chart 3 illustrates the effects of pipe size reduction at the end of a run. Assume a guided pipe cantilever to which a given deflection is to be applied, this deflection resulting in a certain pipe-stress. If the cantilever "leg" is abruptly reduced in diameter the small pipe will be under greater stress due to the smaller section modulus. However, if the small pipe is made longer (percentage-wise) the stress will diminish. This is due, of course, to the greater contribution made toward flexibility by the smaller pipe. The chart shows the variation in stress as the small pipe varies from 0 to 100 percent of the total length. The

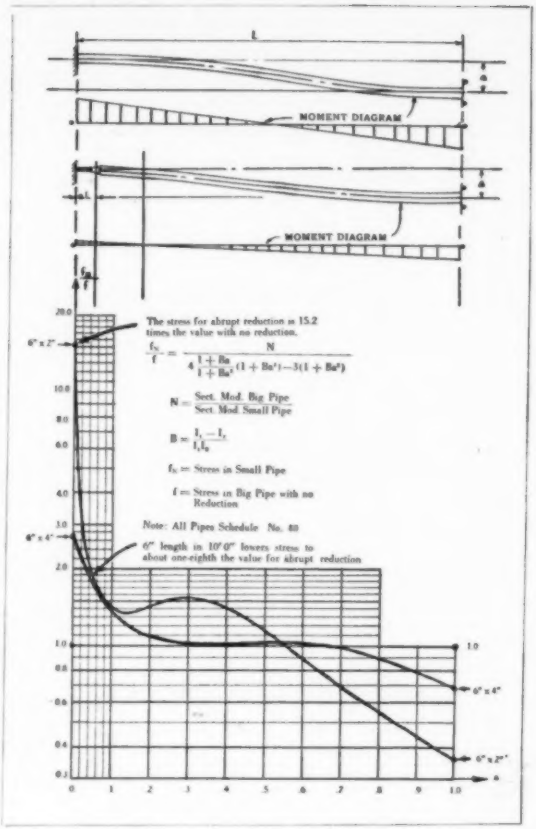
* The large end reactions demonstrate one reason for expansion loops.

‡ Long exchanger tubes can behave in this fashion.

† The straight run and the equal-leg bend can be thought of as limiting cases of all two-leg bends.

left ordinate is the ratio of the section moduli, the right ordinate is the ratio of the diameters. The chart is useful in determining the behavior of pump and compressor piping, where nozzle size is frequently smaller than line size. If the piping layout is determined in the absence of exact nozzle sizes the shape and dimensions (for flexibility considerations) can often be estimated on the basis of line size, using reasonably reduced allowable stresses. While there may be some objection to using a run of nozzle-size pipe any longer than required by fit-up conditions (from pressure drop considerations), this fit-up length may be sufficient to reduce nozzle moments considerably, and a longer length is generally permissible for discharge piping. Even where the reduction is made "abruptly" it is extremely improbable that the theoretically high stresses will actually be obtained, and any slight rotational limberness at the nozzle will have considerable mitigating effect.

CHART 3


L
MOMENT DIAGRAM
MOMENT DIAGRAM
The stress for abrupt reduction is 15.2 times the value with no reduction.
$\frac{f_o}{f} = \frac{N}{4\,\frac{1+Bn}{1+Bn^3}\,(1+Bn^3)-3(1+Bn^2)}$
$N = \frac{\text{Sect. Mod. Big Pipe}}{\text{Sect. Mod. Small Pipe}}$
$B = \frac{I_s - I_r}{I_s I_o}$
f_o = Stress in Small Pipe
f = Stress in Big Pipe with no Reduction
Note: All Pipes Schedule No. 80
6" length in 10'0" lowers stress to about one-eighth the value for abrupt reduction
6" x 2"
6" x 4"
6" x 4"
6" x 2"

Derivations Concerning the Bowing of Long Runs

(See Figure "A", below.)

Let Δ = amount of expansion = ε T L

{ ε = expansion coefficient
{ T = amount of increase in temperature

Assume a cosine curve shape (the error is small and the solution considerably easier than by use of the exact elliptic integral).

$$y = y_o \cos \Phi$$

$$\Phi = -\pi + \frac{2\pi}{L}\,x$$

W_b = internal bending energy

$$= \int_o^L \frac{M^2\,dL}{2EI} \left\{ \begin{array}{l} dL \approx dx \\ M = Py \\ P = \text{the Euler column load} \end{array} \right.$$

$$W_b = \frac{P^2}{2EI}\int_o^L y^2\,dx$$

$$x = (\Phi + \pi)\,\frac{L}{2\pi} = \frac{\Phi L}{2\pi} + \frac{L}{2}$$

$$dx = \frac{L\,d\Phi}{2\pi}$$

$$W_b = \frac{P^2 L\,y_o^2}{4EI\pi}\int_{-\pi}^{+\pi} \cos^2\Phi\;\; d\Phi = \frac{P^2 L\,y_o^2}{4EI}$$

W_c = internal direct compression energy

$$= \frac{P^2 L}{2AE}$$

W_e = external energy

$$= W_c + W_b$$

$$= \frac{P^2 L}{2AE} + P\left(\Delta - \frac{PL}{AE}\right)$$

where

$\left(\Delta - \frac{PL}{AE}\right)$ is the amount of expansion not accounted for by the direct compression

$$W_e = P\Delta - \frac{P^2 L}{2AE}$$

$$W_b = W_e - W_c$$

$$= P\Delta - \frac{P^2 L}{AE}$$

$$\frac{P^2 L\,y_o^2}{4EI} = P\Delta - \frac{P^2 L}{AE}$$

$$y_o^2 = \frac{4\Delta EI}{PL} - \frac{4I}{A}$$

$$P = \frac{4\pi^2 EI}{L^2}\;(= \text{Euler column load})$$

$$y_o^2 = \frac{\varepsilon T L^2}{\pi^2} - \frac{4I}{A}$$

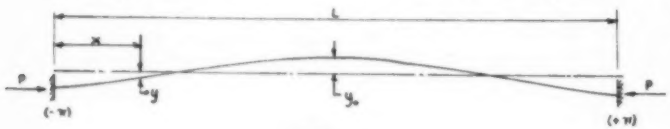


FIGURE A

Letting:

$I \approx \pi R^3 t$ } for thin walled cylinders
$A \approx 2\pi R t$ } where R = outside radius

$$y_o^2 \approx 2R^2\left(\frac{\varepsilon T L^2}{2\pi^2 R^2} - 1\right)$$

$$y_o \approx R\sqrt{\frac{\varepsilon T L^2}{\pi^2 R^2} - 2}$$

To find the stress

$$f = \frac{P\,y_o}{SM} + \frac{P}{A}$$

{ SM = Section Modulus
{ f = Stress

But let

$SM \approx \pi R^2 t$

$a = 4f\pi^2 E$

$b = 16\pi^6 E^2 \varepsilon T$

It can then be shown that:

$$\frac{L}{R} \approx \sqrt{\frac{a + b + \sqrt{-8a^3 + 2ab + b^2}}{2f^2}}$$

and, if it is desired to know what length of pipe will be required to obtain a certain stress "F" at a certain temperature increase "T"

$$L \approx \frac{R}{12F}\sqrt{\frac{a + b + \sqrt{-8a^3 + 2ab + b^2}}{2}}$$

where this equation expresses L in feet and R in inches. The more correct value for the stress in the pipe is:

$$f = \frac{4\pi^2 E}{K^2}\left(1 + \frac{R}{r}\sqrt{\frac{K\epsilon T}{\pi^2} - 4}\right)$$

where r = radius of gyration, $K = \frac{L}{r}$, R = outside radius.

An approximate value for y_o can be obtained as follows:

$$y_o^2 = \frac{\epsilon T L^2}{\pi^2} - \frac{4I}{A}$$

$$\text{when } \frac{\epsilon T L^2}{\pi^2} \gg \frac{4I}{A}$$

$$y_o^2 \approx \frac{\epsilon T L^2}{\pi^2}$$

$$y_o \approx \frac{L\sqrt{\epsilon T}}{\pi} = \frac{\sqrt{L}\,\sqrt{\Delta}}{\pi}$$

= approximate value

Since $y_o^2 \approx 2R^2\left(\frac{\epsilon T L^2}{2\pi^2 R^2} - 1\right)$

there will be no bowing if:

$$\frac{\epsilon T L^2}{2\pi^2 R^2} \leq 1$$

$$\left(\frac{L}{R}\right)^2 \leq \frac{2\pi^2}{\epsilon T}$$

$$\frac{L}{R} \leq \pi\sqrt{\frac{2}{\epsilon T}}$$

or, expressing L as the maximum length to experience no bowing, and calling out L in feet, R in inches

$$L_{max} \approx \frac{\pi R}{12}\sqrt{\frac{2}{\epsilon T}}$$

The expression $\frac{\epsilon T L^2}{2\pi^2 R^2} \leq 1$, indicating the condition for no bowing, is significant in not containing the term E (Young's modulus). This demonstrates that problems in elastic stability are fundamentally problems in geometric relations. "E" occurs in stability calculations for the reason that forces (and moments) are generally the data involved, which are required to be fitted to a structure of known geometry, and "E" correlates the relation between force and geometry. With pipe expansion, of course, the data involved are the deformations, and it is necessary to determine the forces and moments.

Derivation of Guided Cantilever With Size Reduction

(See Figure "B", above.)

I_1 = moment of inertia of large pipe

I_2 = moment of inertia of small pipe

Δ = deflection of cantilever with no size reduction

Δ_a = deflection of cantilever with size reduction

SM_1 = section modulus of large pipe

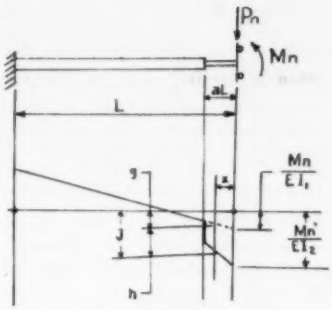


FIGURE B

SM_2 = section modulus of small pipe

Φ = angular end rotation

$$j = \frac{P_n x - M_n}{E I_2}; \quad g = \frac{P_n x - M_n}{E I_1};$$

$$h = \frac{P_n x - M_n}{E I_2} - \frac{P_n x - M_n}{E I_1}$$

$$h = \frac{(P_n x - M_n)(I_1 - I_2)}{E I_1 I_2}$$

$$d\Delta = \frac{M}{E I}\,x\,dx$$

$$\Delta = \int_o^L \frac{M}{E I}\,x\,dx$$

$$\Delta = \int_o^{aL} \frac{(P_n x - M_n)}{E I_1}\,x\,dx + \int_o^{aL} \frac{(P_n x - M_n)(I_1 - I_2)}{E I_1 I_2}\,dx + \int_{aL}^{L} \frac{(P_n x - M_n)}{E I_1}\,x\,dx$$

$$\Delta = \int_o^L \frac{P_n x^2 - M_n x}{E I_1}\,dx + \int_o^{aL} \frac{I_1 - I_2}{E I_1 I_2}(P_n x^2 - M_n x)\,dx$$

$$= \frac{1}{E I_1}\left(\frac{P_n L^3}{3} - \frac{M_n L^2}{2}\right) + \frac{I_1 - I_2}{E I_1 I_2}\left(\frac{P_n a^3 L^3}{3} - \frac{M_n a^2 L^2}{2}\right)$$

$$\Phi = \int_o^L \frac{P_n x - M_n}{E I_1}\,dx + \int_o^{aL} \frac{(I_1 - I_2)}{E I_1 I_2}(P_n x - M_n)\,dx$$

$$= \frac{1}{E I_1}\left(\frac{P_n L^2}{2} - M_n L\right) + \frac{I_1 - I_2}{E I_1 I_2}\left(\frac{P_n a^2 L^2}{2} - M_n a L\right)$$

For no angular change (guided cantilever):

$$\Phi = O = \left(\frac{P_n L^2}{2} - M_n L\right) + \frac{I_1 - I_2}{I_2}\left(\frac{P_n a^2 L^2}{2} - M_n a L\right)$$

Let $\frac{I_1 - I_2}{I_2} = B$; $P_n = \frac{K}{L} M_n$

$$\Phi = O = \frac{K M_n L}{2} - M_n L + \frac{B K M_n a^2 L}{2} - B M_n a L$$

Simplifying

$$K\left(\frac{M_n L}{2} + \frac{B M_n a^2 L}{2}\right) - M_n L - B M_n a L = 0$$

$$K = \frac{1 + B a}{\frac{1}{2} + \frac{B a^2}{2}} = 2\left(\frac{1 + B a}{1 + B a^2}\right) = \frac{P_n L}{M_n}$$

$$P_n = 2\frac{M_n}{L}\left(\frac{1 + B a}{1 + B a^2}\right)$$

$$\Delta_a = \frac{1}{E I_1}\left[\frac{2}{3} M_n L^2 \frac{1 + B a}{1 + B a^2} - \frac{M_n L^2}{2} + \frac{2}{3} B M_n L^3 \frac{1 + B a}{1 + B a^2} a^2 - \frac{B M_n L^2}{2} a^2\right]$$

$$\Delta_a = \frac{M_n L^2}{6 E I}\left[4\frac{1 + B a}{1 + B a^2}(1 + B a^2) - 3(1 + B a^2)\right]$$

Now the deflection of a cantilever with no size reduction, of diameter equal to the large pipe, and with total length equal to total length of size-reduced cantilever

$$\Delta = \frac{M L^2}{6 E I}[1],$$ where M is the end moment

$$\therefore \frac{\Delta_a}{\Delta} = \frac{M_n}{M}\left[4\frac{1 + B a}{1 + B a^2}(1 + B a^2) - 3(1 + B a^2)\right]$$

but $M_n = f_2 SM_2$; $M = f_1 SM_1$

$$\frac{M_n}{M} = \frac{f_2 SM_2}{f_1 SM_1}$$

Let $\frac{SM_1}{SM_2} = N$

$$\frac{M_n}{M} = \frac{f_2}{f_1 N}$$

Let the deflection of the two cantilevers be equal

Then

$$\frac{f_2}{f_1} = \frac{N}{4\frac{1 + B a}{1 + B a^2}(1 + B a^2) - 3(1 + B a^2)}$$

Equal Leg Bend Derivations and Stress Criteria

(See Figure "C," next page)

$$\Delta = \epsilon T L = \frac{P L^3}{12 E I} + \frac{2 P L}{A G} + \frac{P L}{A E}\left(\approx \frac{P L^3}{12 E I}\right)$$

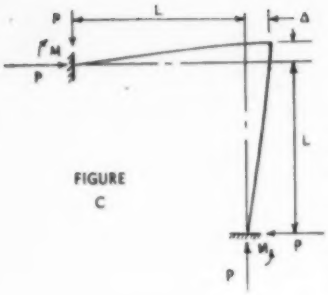


FIGURE C

f_b = bending stress
$= \frac{PL}{2SM}$

f_a = direct stress
$= \frac{P}{A}$

f_s = stear stress
$= \frac{2P}{A}$

f = extreme fiber stress
$= f_b + f_a$
$I \approx \pi R^3 t$
$SM \approx \pi R^2 t$
$A \approx 2\pi R t$

F = allowable fiber stress
F_s = allowable shear stress
T = amount increase in temperature
$T°F. = T + 70°$ = operating temperature
Δ = amount of expansion
ϵ = expansion coefficient
E = Young's modulus
G = shear modulus
A = area
SM = section modulus
I = moment of inertia
R = outside radius
t = wall thickness

$$f \approx \frac{PL}{2\pi R^2 t} + \frac{P}{2\pi R t}; \quad P \approx \frac{f}{\left(\frac{L}{2\pi R^2 t} + \frac{1}{2\pi R t}\right)}$$

$$f_s \approx \frac{P}{\pi R t} \quad ; P \approx f_s \pi R t$$

Stipulating that the extreme fiber stress will not exceed allowable stress:

$$f \leq F$$

substituting $P \approx f_s \pi R t$

$$\frac{f_s L}{2R} + \frac{f_s}{2} \leq F$$

$$\frac{L}{R} \leq \frac{2F}{f_s} - 1$$

Let $F = 18{,}000$; and let $f_s = 12{,}000$ max., to establish an upper limit for $\frac{L}{R}$

$$\frac{L}{R} \leq \frac{36{,}000}{12{,}000} - 1$$

$$\frac{L}{R} < 2$$

The above relationship says that lesser values of $\frac{L}{R}$ will produce fiber stresses less than 18,000 psi., provided that shear stress does not exceed 12,000 psi. Therefore, if the bend is not overstressed in shear, it is not overstressed in fiber stress. Therefore shear stress governs when $\frac{L}{R}$ is less than 2. Since shear stress governs an "allowable temperature limit" can be determined for an $\frac{L}{R}$ less than 2, as follows:

$$\Delta = \epsilon T L = \frac{PL^3}{12EI} + \frac{2PL}{AG} + \frac{PL}{AE}$$

$$\approx \frac{PL^3}{12E\pi R^3 t} + \frac{2PL}{2\pi R t G} + \frac{PL}{2\pi R t E}$$

$$\approx \left(\frac{L}{R}\right)^3 \frac{P}{12E\pi t} + \left(\frac{L}{R}\right)\left(\frac{P}{\pi t G} + \frac{P}{2\pi E t}\right)$$

Let $\frac{L}{R} = K$, $L = RK$; $f_s \approx \frac{P}{\pi R t}$, $P \approx f_s \pi R t$

$$T\epsilon L = T\epsilon RK \approx (K)^3 \frac{f_s \pi R t}{12E\pi t} + (K)\frac{f_s \pi R t}{\pi t}\left(\frac{1}{G} + \frac{1}{2E}\right)$$

$$T\epsilon \approx K^2 \frac{f_s}{12E} + \frac{f_s}{G} + \frac{f_s}{2E}$$

Let: $2 > K \geq 0$

$$T\epsilon \geq f_s\left(\frac{1}{G} + \frac{1}{2E}\right)$$

at: $\epsilon = 6.5 \times 10^{-6}$, $G = 12 \times 10^6$, $E = 29 \times 10^6$, $f_s = 12{,}000$

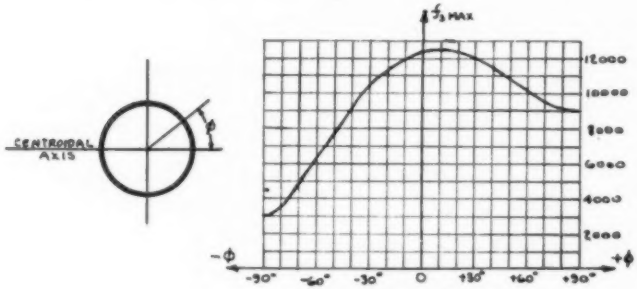


Figure 1. Maximum Shear Stress. (L/R=2)

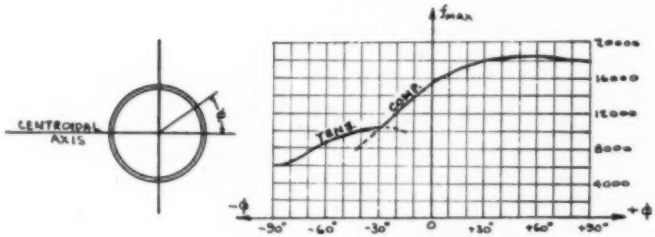


Figure 2. Maximum Normal Stress. (L/R=2)

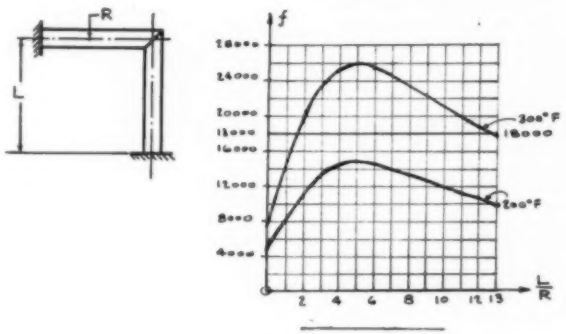


Figure 3. Fiber Stress

$T > 184$

$T° F. = 70 + 184 = 254° F.$

which means that, for $\frac{L}{R}$ less than 2, and for the given allowable stresses, no consideration need be made for the shear (or fiber) stress in the pipe for operating temperatures up to 254° F.

It may be shown as follows, that for $\frac{L}{R} > 2$, fiber stress governs, and no check need be made for shear stress:

Stipulating that the shear stress will not exceed the allowable shear stress:

$$f_s \leq F_s$$

$$\frac{P}{\pi R t} \leq F_s$$

substituting $P \approx \frac{f}{\frac{L}{2\pi R^2 t} + \frac{1}{2\pi R t}} = \frac{2f\pi R^2 t}{L+R}$

$$\frac{2fR}{L+R} \leq F_s$$

$$\frac{L}{2fR} + \frac{1}{2f} \geq \frac{1}{F_s}$$

$$\frac{1}{2f}\left(\frac{L}{R}\right) \geq \frac{1}{F_s} - \frac{1}{2f}$$

$$\left(\frac{L}{R}\right) \leq \frac{2f}{F_s} - 1$$

if $F_s = 12{,}000$ psi., and $f = 18{,}000$ psi., to establish a lower limit for $\frac{L}{R}$

$$\frac{L}{R} \geq \frac{36{,}000}{12{,}000} - 1$$

$$\frac{L}{R} \geq 2$$

This relationship says that greater values of $\frac{L}{R}$ will produce shear stress less than 12,000 psi., provided that the fiber stress does not exceed 18,000 psi. Therefore, if the bend is not overstressed in fiber stress, it will not be overstressed in shear. Therefore fiber stress governs when $\frac{L}{R}$ is greater than 2.

Actually, for an $\frac{L}{R} = 2$ the *maximum* shear stress at the centroidal axis would occur on an axis inclined approximately 7 degrees from the centerline of the pipe. This shear stress would be a few percent greater than the (horizontal) shear stress. Going from the centroidal axis to the extreme fiber, the *maximum* shear stress plots about as shown in Figure 1. The maximum normal (principal) stress at the extreme fiber occurs, of course, parallel to the centerline of the pipe. Actually the *maximum* normal stress occurs at about 60° (not 90°) from the centroidal axis, inclined on an axis about 18° from the centerline of the pipe and is a few percent greater than the extreme fiber stress. It plots about as shown in Figure 2.

Although the maximum normal stress does not occur at the extreme fiber, and the maximum shear stress does not occur at the centroidal axis nor is it horizontal, for small values of $\frac{L}{R}$, the error involved is insignificant for practical piping layouts. Shear stress can generally be altogether neglected. The biaxial stress condition that occurs with combined pressure, expansion and weight stresses can generally be neglected—in the sense that hoop stress is calculated and compared with allowable, and separate determinations of longitudinal stresses (from all causes) made and compared with allowables. "Allowables" as concerned with longitudinal stresses is a somewhat vague term. With pipe temperatures up to about 600° F., the stresses are elastic, and the "stress range" concept is not generally applicable. At higher temperatures "stress range" implies plastic behavior and a stress reversal under cold conditions. Generally, with hot, highly stressed piping, the sum of the longitudinal pressure stress, weight stress, and expansion stress should not exceed the allowable "stress range." Also, the sum of the longitudinal pressure stress and the weight stress should not exceed the hot allowable stress. Purchasers and design-offices vary in the choice of "hot allowables" (within code requirements) and the manner in which combined stresses are calculated and compared. The danger involved in using "stress range" for hot piping is that local instability can occur with large diameter-small thickness piping — manifesting itself by local wrinkling or buckling on the compression side of the neutral axis.

If the expression for the deflection is written in terms of the fiber stress and $\frac{L}{R}$, an "allowable temperature limit" can be established for the condition when fiber stress governs, as follows:

$$\Delta = \varepsilon TL = \frac{PL^3}{12EI} + \frac{2PL}{AG} + \frac{PL}{AE}$$

$$\approx \frac{PL^3}{12E\pi R^3 t} + \frac{2PL}{2\pi RtG} + \frac{PL}{2\pi RtE}$$

substituting $P \approx \frac{f}{\left(\frac{L}{2\pi R^2 t} + \frac{1}{2\pi R t}\right)}$

$$\varepsilon TL \approx \frac{f}{\left(\frac{L}{2\pi R^2 t} + \frac{1}{2\pi R t}\right)}$$

$$\left[\frac{L^3}{12E\pi R^3 t} + \frac{L}{\pi RtG} + \frac{L}{2\pi RtE}\right]$$

Let $K = \frac{L}{R}$, $L = RK$

$$f \approx \varepsilon T \frac{K+1}{\left(\frac{K^3}{6E} + \frac{2}{G} + \frac{1}{E}\right)} = \varepsilon T 6E \frac{K+1}{\left(K^3 + \frac{12E}{G} + 6\right)}.$$

to find the value of K making f a maximum:

$$\frac{df}{dK} = \varepsilon T 6E \frac{-K^3 - 2K + \left(\frac{12E}{G} + 6\right)}{K^4 + K^2 2\left(\frac{12E}{G} + 6\right) + \left(\frac{12E}{G} + 6\right)^2} = 0$$

$$K \approx \frac{2 - \sqrt{4 + 4\left(\frac{12E}{G} + 6\right)}}{-2}$$

When $E = 29 \times 10^6$, $G = 12 \times 10^6$

$K \approx 5$

at $K = 5$, let $f = 18{,}000$ psi.;

$\varepsilon = 6.5 \times 10^{-6}$

$f = 18{,}000 = 6.5 \times 10^{-6} T \frac{6}{60}$

$T = 159$

$T° F. = 70 + 159 = 229° F.$

which means that, for any value of $\frac{L}{R}$, fiber (and shear) stress can be neglected for operating temperatures up to 229° F., for the equal leg bend. Figure 3 plots stress against $\frac{L}{R}$, for various temperatures. Comparison with Table 1 (which neglects shear and direct deformation and is therefore conservative) shows that, for 200° F., the table requires an $\frac{L}{R}$ of about 8, but there is no minimum $\frac{L}{R}$ on a more accurate basis. The table requires, for 300° F., an $\frac{L}{R}$ of about 14, whereas on a more accurate basis $\frac{L}{R}$ should be about 13. For higher temperatures, of course, the table is quite reliable.

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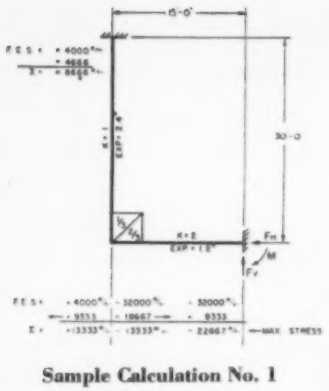
See Sample Calculations on next page.



Sample Calculation No. 1

(Note Figure above.)

Note that one distribution completes the solution.

Data: 900° F. 6-inch diameter, Schedule No. 40 E = 21.5 × 10, Sect. Mod. = 8.5

The fixed end stresses are obtained from Chart No. 1 by multiplying the chart values by the ratio of the moduli of elasticity:

(1) 2.4 inches deflection is taken by the 15 foot-0 inches leg.

(2) From chart, stress is 43,000 psi.

(3) 21.5/30 × 43,000 = 32,000 psi. = F. E. S.

To Find the Forces and Moments:

$$M \text{ (foot pounds)} = \frac{22{,}667 \times 8.5}{12} = 16{,}056 \text{ ft. lbs.}$$

$$F_V \text{ (pounds)} = \frac{-(-13{,}333 - 22{,}667) \times 8.5}{12 \times 15} = 1710 \text{ pounds}$$

$$F_H \text{ (pounds)} = \frac{(8666 + 13{,}333) \times 8.5}{12 \times 30} = 520 \text{ pounds}$$

Sample Calculation No. 2

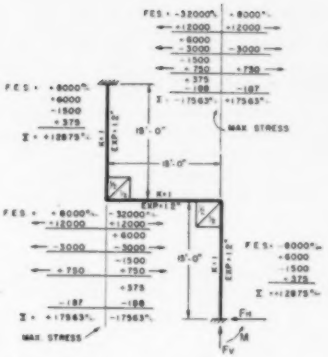
(Note Figure at right.)

Note that sidesway is known for this layout because of symmetry, in other layouts, if sidesway can be predetermined (such as by a directional stop where this restraint may be desirable for some reason) the analysis is simplified. Where no stops are used, a preliminary estimate of the sidesway will render simpler solutions.

Note also, that if the analysis had been stopped after the first distribution, the error would be less than 600 psi. (With no distribution at all, the error for the *value* of the maximum moment is always conservative. However, the *location* of this maximum moment is not defined. A comparison may be made with the "Mitchell Method's" simplifying assumption regarding the position of the neutral axis.)

Data: 900° F. 6-inch diameter, Schedule No. 40. E = 21.5 × 10⁶ Sect. Mod. = 8.5

The fixed end stresses are obtained from Chart No. 1 by multiplying the chart values by the ratio of the moduli of



elasticity:

(1) 0.6-inch deflection taken by the upper and lower 15 foot-0 inch legs.

(2) From chart, stress is 10,800 psi.

(3) 21.5/30 × 10,800 = 8000 psi. = F. E. S.

To Find the Forces and Moments:

$$M = \frac{17{,}875 \times 8.5}{12} = 12{,}650 \text{ foot pounds}$$

$$F_V = \frac{(17{,}563 + 17{,}563) \times 8.5}{12 \times 15} = 1660 \text{ pounds}$$

$$F_H = \frac{(17{,}563 + 12{,}875) \times 8.5}{12 \times 15} = 1440 \text{ pounds}$$

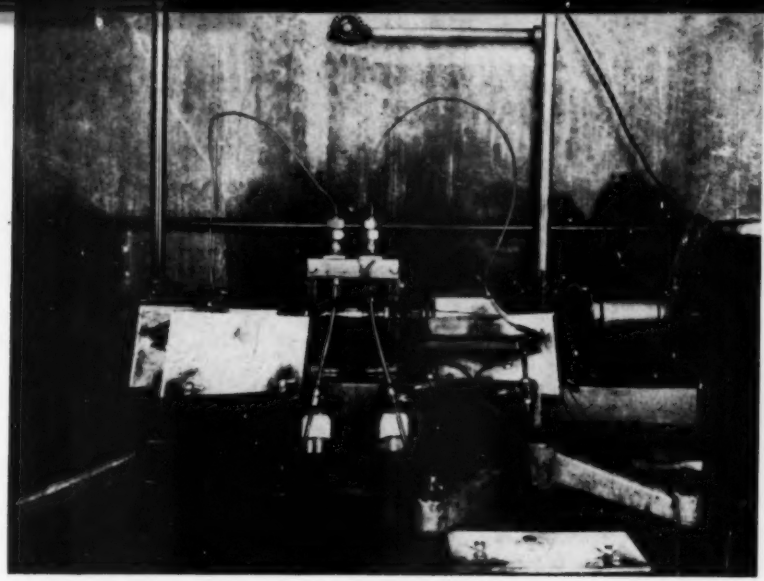
* * *

NEW RESEARCH TECHNIQUE—A new petroleum research technique promising to make possible the manufacture of better lubricants, has now been put into operation at the Beacon Research Laboratories of The Texas Company, according to Dr. W. E. Kuhn, manager, Technical and Research Division. Molecular distillation, the "new technique, provides the petroleum engineer with hydrocarbons not previously available through ordinary distillation and enables the chemist to determine what hydrocarbons make good or bad motor oils.

Dr. Kuhn pointed out that this technique has been used in the past to separate vitamins, hormones and other biologicals into their pure form. It is hoped that the new application not only will make possible the design of more accurate and economical refinery equipment, and also will provide information leading to improved lubricants.

The entire process is conducted at an absolute pressure of about 1 micron of mercury—almost a perfect vacuum, since ordinary atmospheric pressure is about 760,000 microns. The liquid being distilled is spread out in a thin layer—3000 molecules thick, considerably less than the thickness of this paper—and is exposed to the heat of distillation for less than 1/10 of a second. This extremely brief distillation time gives the apparatus a distinct advantage over other types, since decomposition of the hydrocarbons is held to a minimum. This is very important, because exposing the material to heat for an appreciable period of time may seriously change its molecular structure and give false information as a result.

The apparatus consists of a shallow steel cone, 14 inches in diameter, which is spun by an electric motor at 1725 revolutions per minute. The oil is fed to the center of the cone through a tube and centrifugal force spreads the oil over the surface in a fraction of a second. The cone is radiantly heated and the more volatile (lighter) portions of the oil are distilled off and collected, while the less volatile portions are thrown off the edge and collected as the residue.



Apparatus for a method, which simulates the characteristic engine deposit in engine testing of motor oils, provides results that correlate well with actual engine performance. Oil from a beaker reservoir (center) is made to flow in a thin film at a regular rate over a weighed steel strip which is maintained at an elevated temperature and is recirculated for a definite period by means of a motor, pumps, and copper piping (background). The shields on the sides of the steel strips and heater assemblies prevent air currents from affecting the results (Note that one of shields on the right assembly has been removed). After washing by a method which removes any adhering oil without the loss of deposit, the strip is again weighed to obtain a numerical as well as visual indication of the amount of deposit formed.

Stability Test for Additive-Motor Oils

A NEW evaluation test for lubricating oils with additives, which simulates the characteristic deposits found in engine tests of motor oils, has been developed in the lubrication laboratory of the National Bureau of Standards by S. A. McKee and Ann Robinson Fritz. The method not only offers a sensitive laboratory measure of the effectiveness of various additives in motor oils but also has several advantages over the present testing procedure, which involves disassembly of the test engine and an examination of its parts.[1] The new test, requiring but simple laboratory apparatus, is time saving, is less expensive, and eliminates the fuel variable that results from contamination of the oil by the engine fuel in the conventional method. Most important, it gives a quantitative as well as visual rating of an oil, providing more consistent results and reducing the subjectivity of individual operators.

Such a stability test for additive-treated materials may also prove useful as a quick check for control purposes. Many companies now prohibited by cost from running engine tests may also find it an inexpensive method for checking their oil purchases.

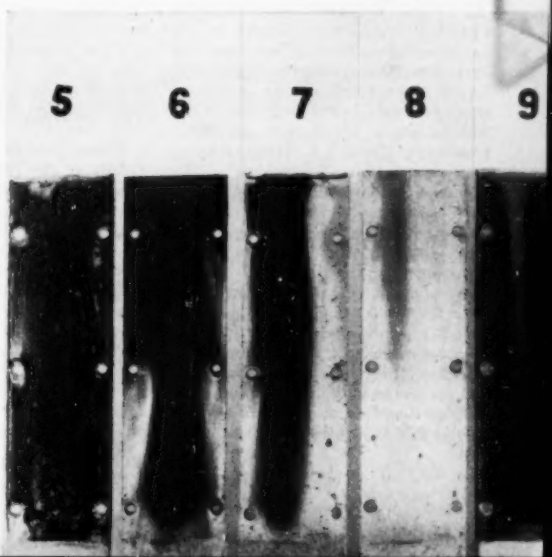
The new test method consists essentially of circulating the oil sample in a thin film over a heated steel strip, quite similar to the oil film on an engine cylinder wall. A mechanical lubricator pump delivers the oil from a small glass container to the upper end of the thin steel strip which is held in an inclined position and maintained at the test temperature. The oil leaving the lower end of the plate drops into the reservoir and is recirculated. The amount of deposit on this strip provides a sensitive means for rating the lubricating oil under test.

In general, the oils used in the Bureau's investigation are in commercial production and have a considerable background of service performance. They include oils with no additives, premium-type additive oils containing inhibitors and/or detergents, and full heavy-duty oils containing additives that meet U. S. Army Ordnance 2-104B and Navy 9000 series specifications.

The Bureau's tests were made with weighed samples of 150 ml of oil in 250 ml beakers under the following conditions: Temperature, 250° C; oil delivery, approximately 0.7 grams per minute; and slope of strip, 8.5 degrees from the horizontal. This temperature approximates the high temperature regions in the engine under full power operation.

Data obtained with the new test give a sensitive indication of the effectiveness of inhibitors, detergents, and their combinations. The particular conditions under which the Bureau tests were conducted tend to accentuate the effectiveness of full heavy-duty additive oils. The apparatus is sufficiently flexible, however, to cover a wide range of conditions which might be more suitable for premium grade oils or which would give additional information on the overall effectiveness of a given oil-additive combination.

The correlation of the laboratory stability test with engine performance is sufficiently satisfactory to justify further work.



Set of test strips showing effectiveness of various additives in a midcontinent, solvent extracted oil. Formation on strip 5 resulted from a straight oil (no additive) while sample 6 contained oxidation inhibitor but no detergent; sample 7, a premium additive with some inhibitor and detergent; sample 8, a premium additive with the full amount inhibitor and detergent (Army Ordnance 2-104B); and sample 9, with a detergent but no inhibitor.

[1] For further details see "Stability Test for Additive Treated Motor Oils" by S. A. McKee and A. R. Fritz, *Analytical Chemistry*, May 1949.

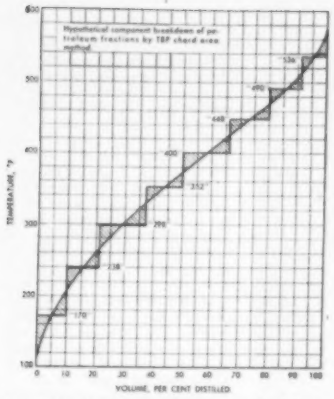


Figure 103. Hypothetical Component Breakdown of Petroleum Fractions by TBP Chord Area Method.

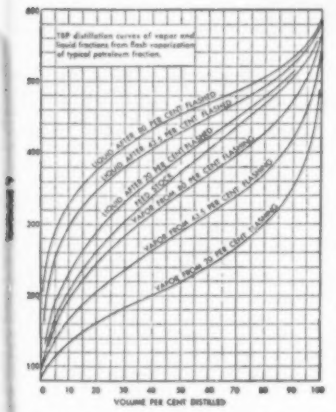

TBP distillation curves of vapor and liquid fractions from flash vaporization of typical petroleum fraction.
LIQUID RATIO 90 PER CENT FLASHED
LIQUID RATIO 50 PER CENT FLASHED
LIQUID RATIO 10 PER CENT FLASHED
MID-BOOK
VAPOR FROM 90 PER CENT FLASHED
VAPOR FROM 50 PER CENT FLASHED
VAPOR FROM 10 PER CENT FLASHED
VOLUME PER CENT DISTILLED

Figure 104. Typical TBP Distillation Curves of Vapors and Liquids From Three Equilibrium Flash Vaporizations of Petroleum Fraction.

Applications of Thermodynamics To Hydrocarbon Processing

PART XXV—Properties of Vapor and Liquid from Equilibrium Flash Vaporization of Petroleum Fractions

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CHARTS FOR estimating the API gravities and the ASTM distillation curves of vapor and liquid products from equilibrium flash vaporization of petroleum fractions are presented in this installment. These empirical correlations have been developed from the same experimental data used in developing the correlations given in Parts XXIII and XXIV (October and November, 1949, issues of Petroleum Refiner).

IN THE TWO previous installments empirical correlations, based on experimental equilibrium flash vaporization data, for estimating the vapor-liquid phase conditions of petroleum fractions were presented and illustrated. These correlations permitted predicting the P-T-X (i.e., pressure-temperature-percent vaporized) relationships for petroleum fractions by first estimating the atmospheric pressure flash curve and then finding the flash curves at other pressures by constructing a phase diagram from this atmospheric EFV curve and the critical data for the fraction.

P-T-X conditions alone are sufficient for the solution of some design and operating problems but in most cases the properties of the equilibrium vapor and/or liquid are required in addition to the P-T-X information. The objective of this, the final installment on phase equilibria, is to complete the empirical correlations necessary for making vapor-liquid phase equilibria calculations for petroleum fractions by presenting charts for estimating the properties of vapor and liquid from flash vaporization.

Vapor-Liquid Distillation Curves by Component Method

When making vapor-liquid phase equilibria calculations by the *theoretical component* method, the compositions of the equilibrium vapor and liquid products are found as a result of the P-T-X calculations. This component method may be applied to a petroleum fraction by means of a hypothetical component breakdown, made from a TBP. curve, in the manner illustrated in Figure 103, which is for the same fraction appearing in Figures 89 and 90 (Part XXIII).

A petroleum fraction is divided into hypothetical components by first breaking the TBP. curve into a series of equivalent plateaus and then estimating the gravities and molecular weights of these segments. From this information, the mole fractions of these hypothetical components can be estimated, as can be the other properties of the "components."

These hypothetical component calculations are preferably based upon a precise laboratory TBP. distillation of the fraction. While making this batch distillation, a small additional effort will also obtain a gravity vs. percent-off curve. Lacking laboratory data it is possible to estimate the TBP. curve from the ASTM curve by the charts in Part XXIII and then, after dividing the TBP. into hypothetical components, to estimate the gravities of these components from the gravity and characterization factor of the entire fraction. From boiling points and gravities, the other properties, such as mole weights, critical constants and fugacities, etc., may be estimated for the hypothetical components.

The number of hypothetical components into which the fraction is broken is dependent upon the type of computation to be made and the accuracy desired. In calculating dew points, the higher boiling portion of the fraction is the most important. In calculating bubble points, the lower boiling portion of the fraction is most important. In any case this procedure amounts to lumping many actual components together and calling the mixture a hypothetical component. On Figure 103 the TBP. curve is divided into eight hypothetical components, which are identified by their average boiling points or the temperature level of the chords. More or less hypothetical components may be obtained by this method of TBP. breakdown, as desired. The shape of the TBP. curve should be taken into consideration in making this breakdown. Any naturally occurring plateaus of flat regions should be components in the breakdown, even though this might result in hypothetical components of widely varying percentages.

From the estimated gravities and molecular weights of these hypothetical components, the liquid volume

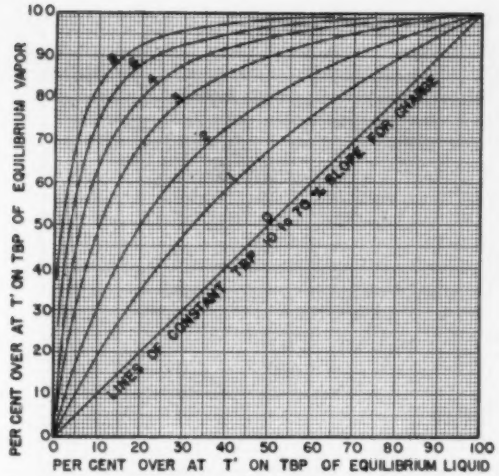
PER CENT OVER AT T' ON TBP OF EQUILIBRIUM VAPOR
PER CENT OVER AT T' ON TBP OF EQUILIBRIUM LIQUID
LINES OF CONSTANT TBP 10 to 70 % SLOPE FOR CHARGE

Figure 105. Relationship Between TBP Distillation Curves of Equilibrium Vapors and Liquids From Petroleum Fractions of Various Slopes. (Source: Katz & Brown[3])

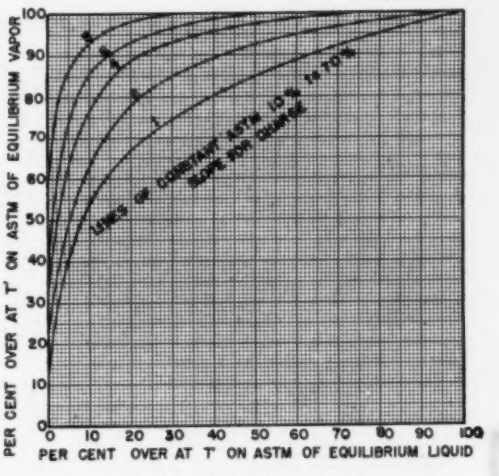
PER CENT OVER AT T' ON ASTM OF EQUILIBRIUM VAPOR
PER CENT OVER AT T' ON ASTM OF EQUILIBRIUM LIQUID
LINES OF CONSTANT ASTM 10 % TO 70 % SLOPE FOR CHARGE

Figure 106. Relationship Between ASTM Distillation Curves of Equilibrium Vapors and Liquirs From Petroleum Fractions of Various Slopes. (Source: Katz & Brown[3])

percentages are converted to mole percentages, the latter being required for the equilibrium calculations because of the units of K (i.e. the ratio of vapor mole fraction to liquid mole fraction). This calculation is illustrated in Table 57 for the breakdown given on Figure 103. The densities (given in pounds per gallon) were estimated by successive approximations so that the computed gravity of the mixture agreed with the known value of 43.2° API, the variation of density with boiling point being estimated graphically from the similar variation for hydrocarbons.

By reference to Table 57 it will be noted that the percentage distribution of the components is different on a mole basis than on a liquid volume basis. For the lightest component 10 liquid volume percent becomes 13.77 mole percent. For the heaviest component 9 liquid volume percent becomes 6.62 mole percent. Because of this percentage shift it is necessary to make the conversion illustrated in Table 57.

Using the hypothetical component breakdown given in Figure 103 and Table 57 and vapor pressures, three equilibrium flash vaporization calculations were made by the component method for 20, 43.5 and 80 percents flashed. The results obtained by these calculations were in terms of the amounts of the eight hypothetical components in the vapor and liquid products from each flash separation. True boiling point curves were drawn from these data by reversing the chord area procedure shown in Figure 103.

These TBP. distillation curves of the equilibrium vapor and vapor from these three flash separations are given in Figure 104 along with the TBP. curve of the charge. The curves shown on Figure 104 are typical of those obtained for any petroleum fraction. As the percentage flashed to vapor is increased the TBP. distillation curve of the vapor approaches that of the feed stock. On the other hand, as the percentage flashed to vapor is decreased, the TBP. distillation curve of the liquid approaches that of the feed stock.

TABLE 57

Calculation of Mole Percentages for Hypothetical Components on Figure 103

Component	Liquid Volume Percent	PROPERTIES			Lbs. per 100 Gal.	Moles per 100 Gal.	Mole Percent
		B.P. °F.	Lbs./Gal.	Mole Wt.			
"170"	10	170	5.80	90	58.0	0.644	13.77
"238"	11	238	6.25	109	68.8	0.631	13.50
"298"	16	298	6.50	126	104.0	0.826	17.65
"352"	13	352	6.75	142	87.5	0.616	13.16
"400"	16	400	6.90	160	110.4	0.691	14.76
"448"	14	448	7.10	180	99.4	0.552	11.80
"490"	11	490	7.25	195	79.7	0.409	8.74
"536"	9	536	7.40	215	66.6	0.310	6.62
	100				674.4	4.679	100.0

The data shown on Figure 104 may be presented in another way by plotting the corresponding percentages over at any temperature for the vapor and the liquid. When this is done a curve similar to one of the curves in Figure 105 is obtained. This method of plotting distillation curves of equilibrium vapor and liquid was suggested by Obryadchakoff.[4]

Figure 105 was replotted from the original of Katz and Brown[3] who found that a single plot could be made to represent the data for many petroleum fractions by adding the slope parameter, shown on Figure 105. Such a correlation of distillation data on equilibrium vapor and liquid is only an approximate representation of the data. The actual points scatter badly when plotted in this manner.

This scattering is illustrated in Table 58 where points from Figure 104 are compared with values from Figure 105. Readings of Figure 105 are made along a slope line of 3.9 (i.e. [438 — 208] ÷ 60), which is the 10—70 slope of the feed. Readings of Figure 104 were made for each of the three pairs of distillation curves, readings being made at the percentages where the TBP. curves of the liquid and vapor cross the same temperature line. The three sets of readings from Figure 104 are identified by the amount flash vaporized. It can be seen that the values of the points on the vapor TBP., corresponding to the same points on the liquid TBP., vary widely and that only the values for the 20 percent flashed

Text continued on page 145
Note three intervening figures

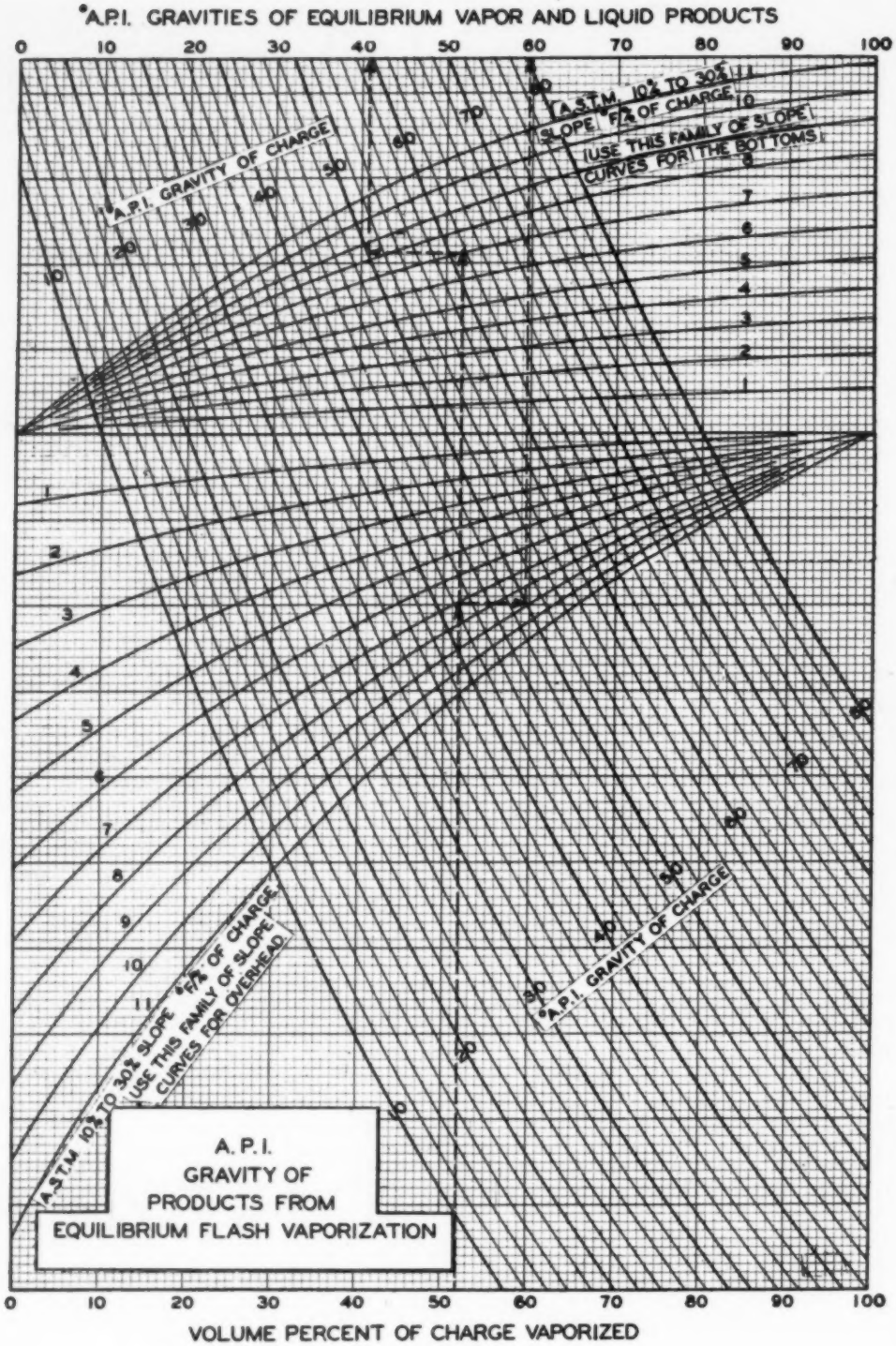
°A.P.I. GRAVITIES OF EQUILIBRIUM VAPOR AND LIQUID PRODUCTS
0 10 20 30 40 50 60 70 80 90 100
°A.P.I. GRAVITY OF CHARGE
A.S.T.M. 10% TO 30% SLOPE °F. OF CHARGE
USE THIS FAMILY OF SLOPE CURVES FOR THE BOTTOMS
A.S.T.M. 10% TO 30% SLOPE °F. OF CHARGE
USE THIS FAMILY OF SLOPE CURVES FOR OVERHEAD
°A.P.I. GRAVITY OF CHARGE
A. P. I.
GRAVITY OF
PRODUCTS FROM
EQUILIBRIUM FLASH VAPORIZATION
VOLUME PERCENT OF CHARGE VAPORIZED

FIGURE 107

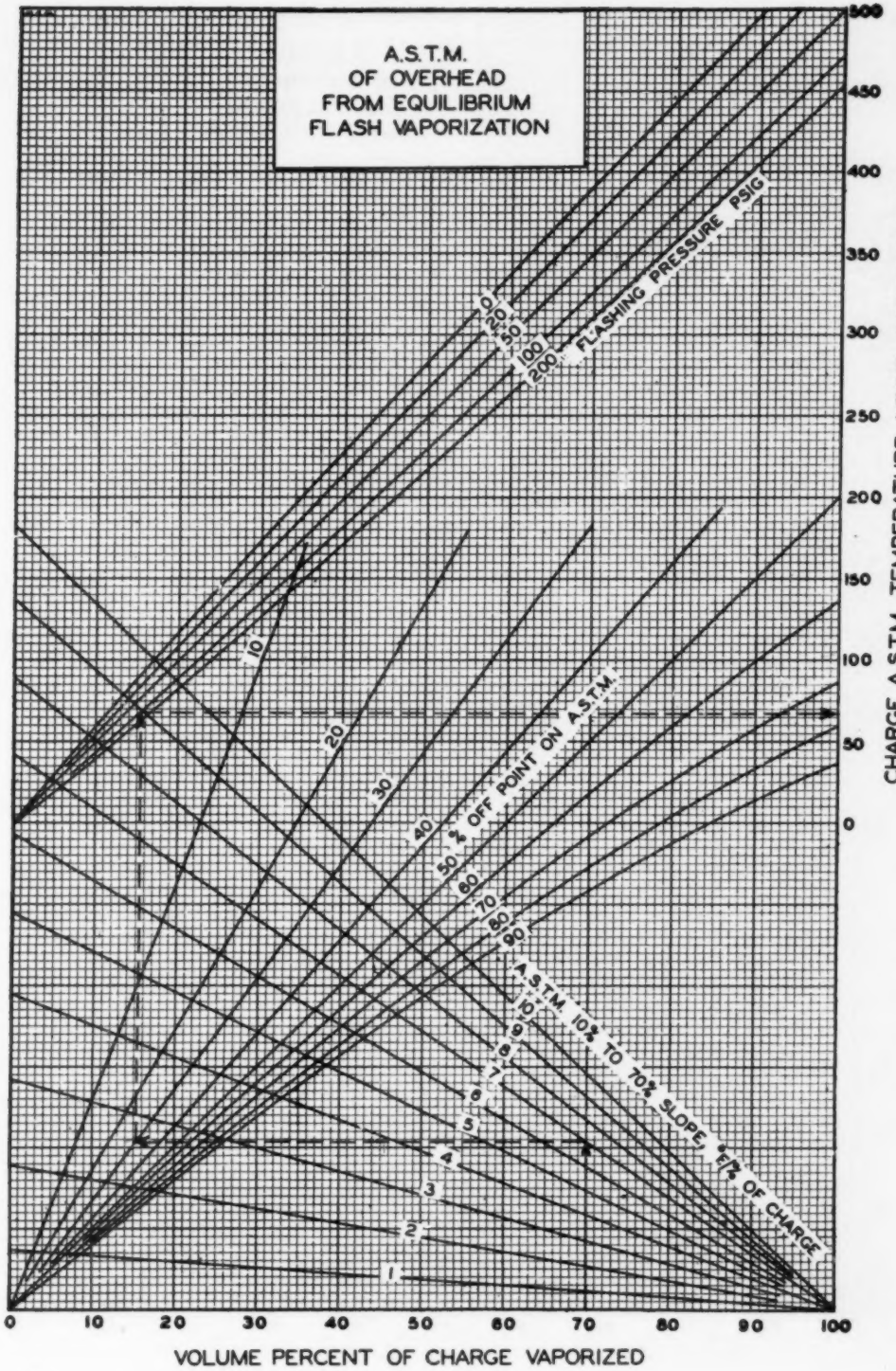
A.S.T.M.
OF OVERHEAD
FROM EQUILIBRIUM
FLASH VAPORIZATION
FLASHING PRESSURE PSIG
0
20
50
100
200
10
20
30
40
50
60
70
80
90
% OFF POINT ON A.S.T.M.
A.S.T.M. 10% TO 70% SLOPE, °F./% OF CHARGE
10
9
8
7
6
5
4
3
2
1
CHARGE A.S.T.M. TEMPERATURE MINUS CORRESPONDING OVERHEAD A.S.T.M. TEMPERATURE, °F.
500
450
400
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80
90
100
VOLUME PERCENT OF CHARGE VAPORIZED

FIGURE 108

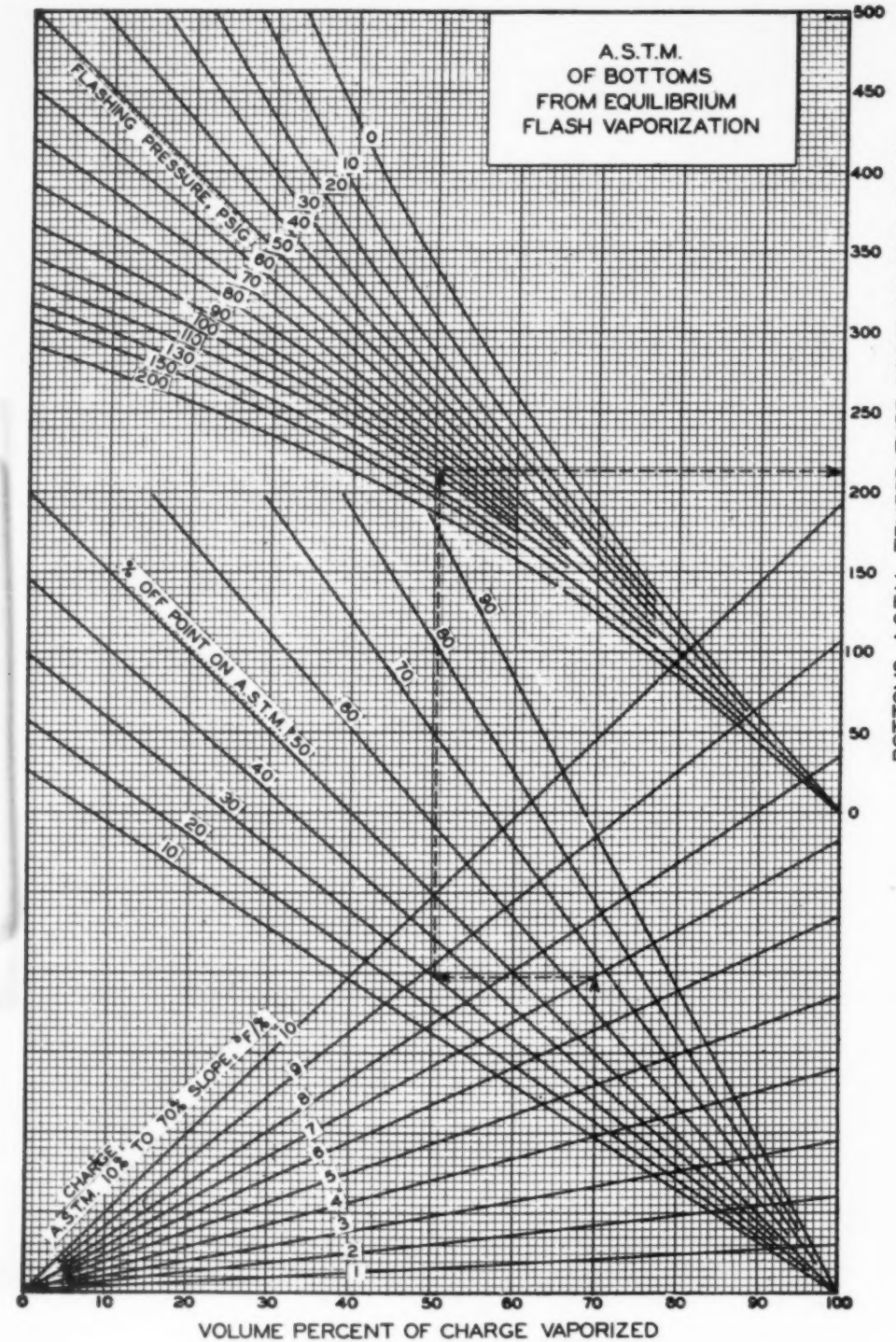
A.S.T.M.
OF BOTTOMS
FROM EQUILIBRIUM
FLASH VAPORIZATION
FLASHING PRESSURE, PSIG
0
10
20
30
40
50
60
70
80
90
100
110
130
150
200
% OFF POINT ON A.S.T.M.
10
20
30
40
50
60
70
80
90
A.S.T.M. CHARGE SLOPE, °F./%
10 TO 70%
1
2
3
4
5
6
7
8
9
10
BOTTOMS A.S.T.M. TEMPERATURE MINUS CORRESPONDING CHARGE A.S.T.M. TEMPERATURE, °F.
500
450
400
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80
90
100
VOLUME PERCENT OF CHARGE VAPORIZED

FIGURE 109

TABLE 59

Calculation of Distillation Curves of Vapor and Liquid From Flashing Petroleum Fraction

Percent Off	Charge		Vapor from 43.5% Flashing			Liquid After 43.5%		
			Via Hypothetical Component Calcs. (Fig. 104)		Via Empirical Method (Fig. 108)	Via Hypothetical Component Calcs. (Fig. 104)		Via Empirical Method (Fig. 109)
	TBP.	ASTM.	TBP.	ASTM.	ASTM.	TBP.	ASTM.	ASTM.
10	208° F.	248° F.	163° F.	211° F.	214° F.	295° F.	335° F.	328° F.
30	302	322	237	259	257	380	395	382
50	373	374	290	294	289	430	429	419
70	438	424	339	329	324	470	457	456
90	508	486	420	391	381	525	502	511

case agree with Figure 105. This comparison is made with calculated rather than observed TBP. curves. It does not seem likely that a similar comparison on experimental data would indicate any better agreement. From this it appears that plots such as Figure 105 are of little practical value unless other parameters such as percent flashed and/or pressure, are added.

TABLE 58

Comparison of Figure 105 With Values From Figure 104

Percent on TBP. of Liquid	Values of Percent on TBP. of Vapor			
	Fig. 105 1.9 Slope	Fig. 104 20% Flashed	Fig. 104 43.5% Flashed	Fig. 104 80% Flashed
5	40	35	36	32
10	60	54	51	44
15	71	68	64	55
20	78	76	72	63
25	83	83	77	70
30	87	87	82	74
40	91	92	88	82

Such an improvement is not justfiied because the plot is already too awkward to use due to the fact that temperatures have been eliminated in its construction, thus making the estimation of a TBP. curve for an equilibrium vapor or liquid more difficult than it needs to be. The determination of temperature involves calculations using: readings from Figure 105, the TBP. curve of the charge, and the percent flashed. The procedure is to make readings of percents on vapor and liquid TBP. curves from the proper slope curve on Figure 105 and then combine these percentages in the proportions of the amounts of vapor and liquid produced in the flash separation under consideration. This combination will give the value of the percent off on the feed TBP. at the same temperature so it is an easy matter to find the temperature from the feed TBP. The reason for estimating temperatures in this way should be evident from Figure 104 where a few calculations will show that vapor and liquid TBP. curves can be combined at constant temperatures, to give the feed TBP. curve.

Katz and Brown[3] also prepared a similar plot for the ASTM distillation curves of the equilibrium vapor and liquid from flash vaporization. Figure 106 is a redrawn copy of this empirical correlation, which is applied in the same manner as Figure 105.

Proposed New Correlations

From the experimental data of Edmister et al.,[1,2] used in the development of the correlations given in the two previous installments, three empirical correlations have been developed for predicting the gravities and ASTM distillations of the equilibrium vapor and liquid from flash vaporization. These correlations are presented here as Figures 107, 108 and 109. In using these charts, the fact that they are strictly empirical with no theoretical basis should be remembered.

Figure 107 may be used to estimate the API gravities of the vapor and liquid products from equilibrium flash vaporization. The ASTM 10-30 slope of the charge, in addition to the gravity of the charge and the percent flashed, are the variables used in this empirical correlation. The vaporization conditions (i.e. pressure or temperature) do not enter into this correlation as the product gravities are independent of the vaporization conditions. In developing Figure 107 many weight balances were made to supplement the actual data so as to make certain that the charge and product gravities were all consistent with each other.

An example, indicated by the dashed lines and arrows, illustrates the method of reading Figure 107. In the example a 50° API stock with a 7° F. per percent slope is flashed with 52 percent going to the vapor overhead. Following the arrows, the product gravities are found to 40.8 and 59.6° API for the bottoms and overhead, respectively.

Figures 108 and 109 are empirical charts for estimating the ASTM distillations of the overhead and bottoms products from equilibrium flash vaporization of petroleum fractions. These calculations are based on the ASTM of the charge and are made for each 10 percent interval on the ASTM distillations. As can be seen by reference to Figure 108 and 109, the readings from these charts are differences between the corresponding points on the product and charge distillation curves. In these correlations the 10-70 ASTM slopes are used and flashing pressure is a variable.

The application of these charts is illustrated by the examples in dashed lines with arrows. In this example a stock having a 10-70 slope of 7° F. per percent is flashed at 100 psig. with 70 percent going to the vapor overhead. From Figure 108, by following the arrows, the 30 percent point on the ASTM of the overhead is found to be 67° F. lower than the corresponding point on the ASTM of the charge. From Figure 109, by following the arrows, the 30 percent point on the ASTM of the bottom is found to be 212° F. higher than the corresponding point on the ASTM of the charge.

For one of the flash vaporization separations shown on Figure 104, namely the 43.5 percent flashed, the product distillation curves estimated by use of Figures 108 and 109 are compared with those obtained by converting the calculated (via hypothetical components) TBP. curves to ASTM. This conversion is made by means of Figures 91 and 94 of Part XXIII. The results of these calculations are given in Table 59, from which it can be seen that Figures 108 and 109 are in good agreement with the curves obtained from hypothetical component calculations.

Figures 108 and 109 could be used in multistage petroleum fractionation calculations if there were some convenient way of combining vapor and liquid going to a plate to obtain the ASTM of the mixture being flashed on the equilibrium plate.

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[1] Edmister, W. C. and Pollock, D. H. "Phase Relations for Petroleum Fractions." Chem. Eng. Progress **44**, 905 (1948).

[2] Edmister, W. C., and Reidel, J. C., and Merwin, W. J. "Equilibrium Flash Vaporization of Three Petroleum Fractions." Trans. Am. Inst. Chem. Eng. **39**, 467 (1943).

[3] Katz, D. L., and Brown, G. G. "Vapor Pressure and Vaporization of Petroleum Fractions." Ind. Eng. Chem. **25**, 1373 (1933).

[4] Obryadchokoff, Ind. Eng. Chem. **24**, 1155 (1932).

EDITOR'S NOTE: This installment completes Section II of this series on Thermodynamics. Reprints of these 13 installments will soon be available ($1.00 per copy). After an interval of a few months the third and last section of these articles will start in PETROLEUM REFINER. *In these coming installments the author will cover application of thermodynamics to: chemical reactions, combustion, compression, expansion, refrigeration, fluid flow, heat transfer, distillation, etc.*

Four million dollars worth of maintenance and construction work a year are handled in the maintenance shop building recently completed at Shell Oil Company's refinery near Houston. Above, the small building near the shop houses sand spray and sand blasting equipment for cleaning parts brought in from the refinery. The one story offset along the side of the shop holds offices for various craft foremen.

Above at left — Two of builders look over the job as it near completion.

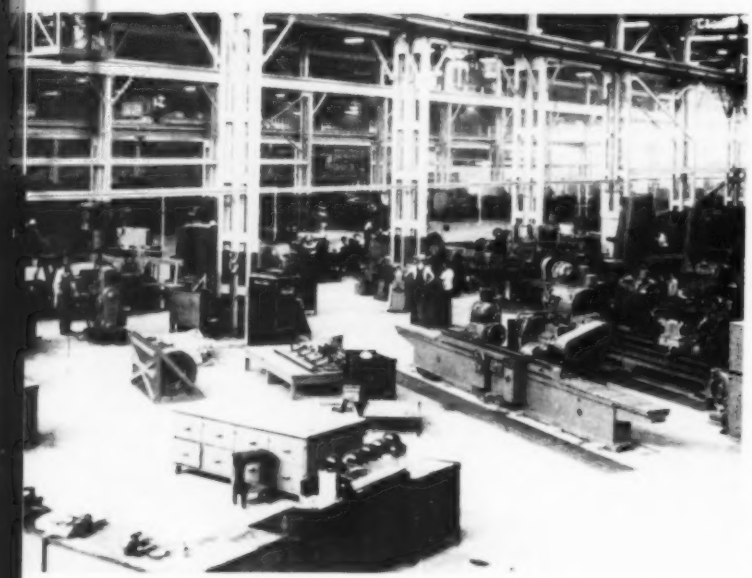
New Maintenance Shop Building at Shell Plant

A SHOP building designed to handle $4 million worth of maintenance and construction work a year has been completed at Shell Oil Company's Deer Park refinery near Houston. The chief purpose of the new shop is to consolidate the refinery's maintenance operations, which have outgrown older quarters at widely separated parts of the plant.

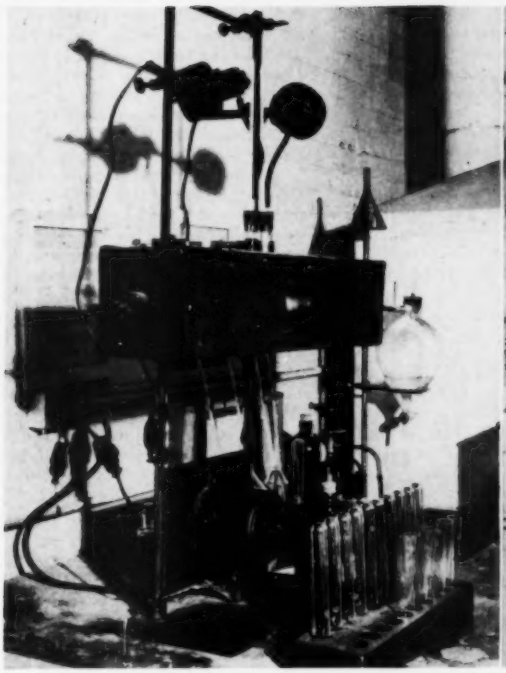
According to Refinery Manager P. E. Foster, the Shell engineers who designed the building incorporated many new features developed from surveys of shop practices and materials handling methods in over 25 major industrial establishments and military depots throughout the country. The building has 98,000 square feet of floor space, mercury vapor and incadescent lamps to reduce eye strain, and three traveling bridge cranes that move the length of the building for ease in moving heavy articles from one part of the shop to another.

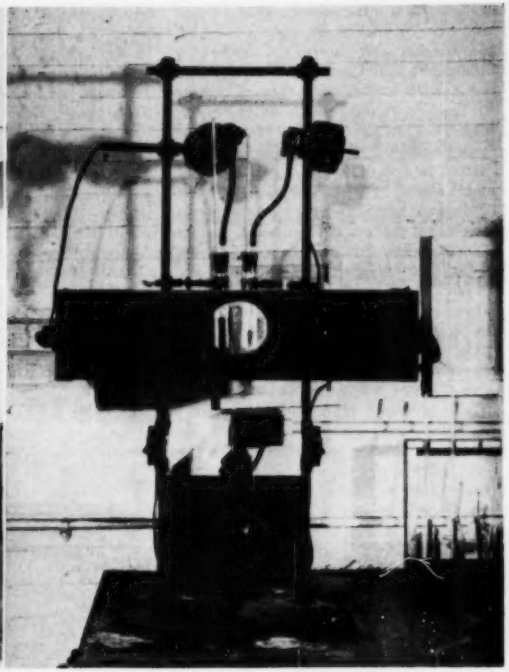
A special cleaning building, housing equipment that removes dirt and oil from parts brought in from the refinery, insures the main shop of cleanliness unusual in maintenance operations. Working conditions are further improved by an air conditioning system that maintains an inside temperature of 80 when it is 95 out of doors.

Besides its complete assortment of machines, tools, and equipment needed in refinery maintenance, the shop includes offices for craft foremen, a separate tool room, conference rooms, space for storage of heavy materials, and lockers and wash rooms.



At left — The new maintenance shop, recently built at Shell Oil Company's refinery near Houston, Texas, is fully equipped for repairing and servicing virtually any of the parts of the refinery's oil processing units. Lathes, presses and gang drills in the foreground are in the machine shop section. The welding section is in the center background, and a track for a traveling bridge crane runs across the top of the picture. The building also includes a large tool room, conference room, storage space for materials, and an instrument section.





Figures 1 and 2—Views of the Aniline Point Determination Apparatus as Set Up Ready for Use. Sockets for the infrared heat lamps can be seen at each end of the galvanized metal transite shielded box, the voltage adjusting transformer is mounted on the baseboard, and electric stirrers and thermometers are in place in the test tubes which can be observed through the central observation window.

Aniline Point Determination By Use of Infrared Lamps As the Source of Heat

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***EQUIPMENT** described in this article proved highly satisfactory to the author in the determination of aniline points in the laboratory. Better control and accuracy, plus less time for the operation, is one of the objectives of the laboratory as well as the plant. While routine testing methods are in daily use, it is not often that the effort is expended toward their improvement as is shown here.*

This description of the equipment used will be of interest to those engaged in this division of refining.

THE heating bath used in aniline cloud point determination is described in ASTM Designation D611-44T, Section 3G, as follows: "A suitable non-aqueous, non-volatile, transparent liquid bath. An open flame or a hot air gun may be substituted for the liquid bath, but hot water should not be used as aniline is hygroscopic."

The liquid baths commonly used are either glycerine or a transparent oil. Both have a tendency to turn dark on heating and require considerable time to heat to a temperature just above the aniline cloud point. Due to its heat capacity, the liquid bath continues to heat the sample even though the heating source has been removed. This requires considerably more time to run each test because the ASTM procedure calls for a cooling rate of not more than 1° C. per minute from the point of maximum temperature to the cloud point. The procedure calls for observation of the cloud point several times and this can be accomplished only by alternately heating and cooling the liquid bath. After the test is finished the bath must be refilled with fresh liquid or the hot liquid must be cooled.

The open-flame method of heating samples is impractical because of the volatile nature of some of the samples that require aniline numbers and also due to the fact that an open flame in a petroleum testing laboratory is definitely a fire hazard.

The hot-air gun seems impractical because of the necessity of locating the aniline number equipment near a steam box or electric furnace used to heat the air. The noise of the air jet would also make this unsuitable for most laboratories.

The apparatus which was found to be highly satisfactory for aniline point determination consists of an oblong box of 24-gauge galvanized iron open

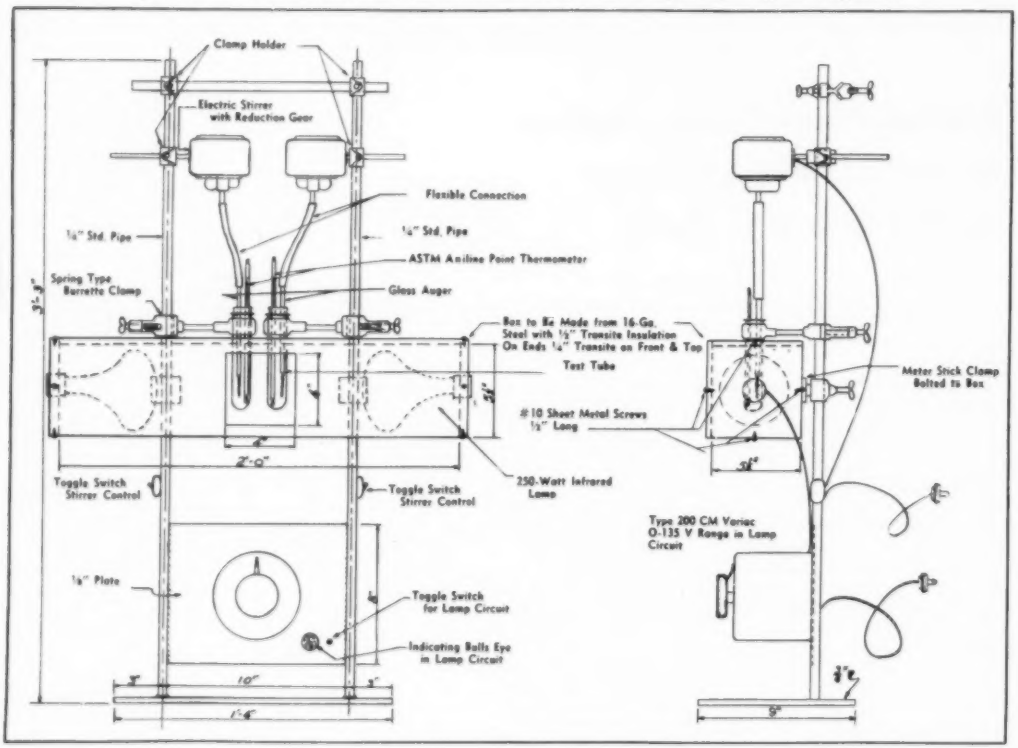
at both ends. The dimensions of the box are 24 inches by 5½ inches by 5½ inches. Two holes 1⅛ inches in diameter are drilled in the top of this box 1-1/16 inches each side of center. In the front and back, center, openings 4 inches by 4 inches are cut and at each end of all four sides holes are drilled to accommodate a No. 10 sheet metal screw ½ inch long. To the back of the box two regular meter-stick type ring-stand clamps are bolted at points 5 inches each side of center. The ends of the box are made of Transite plates ½ inch by 5½ inches by 5½ inches. Holes of suitable size are drilled in the center and regular 115-volt light sockets are attached to the plates to accommodate 250-watt infrared lamps. These plates are fitted into each end of the box and made secure by four No. 10 ½-inch sheet metal screws. To protect the tester from heat from the box, plates of ¼-inch Transite are made to fit on the top and front of the box. Holes are cut in the plates to coincide with the openings in the box and are attached by means of the same metal screws used to secure the Transite ends.

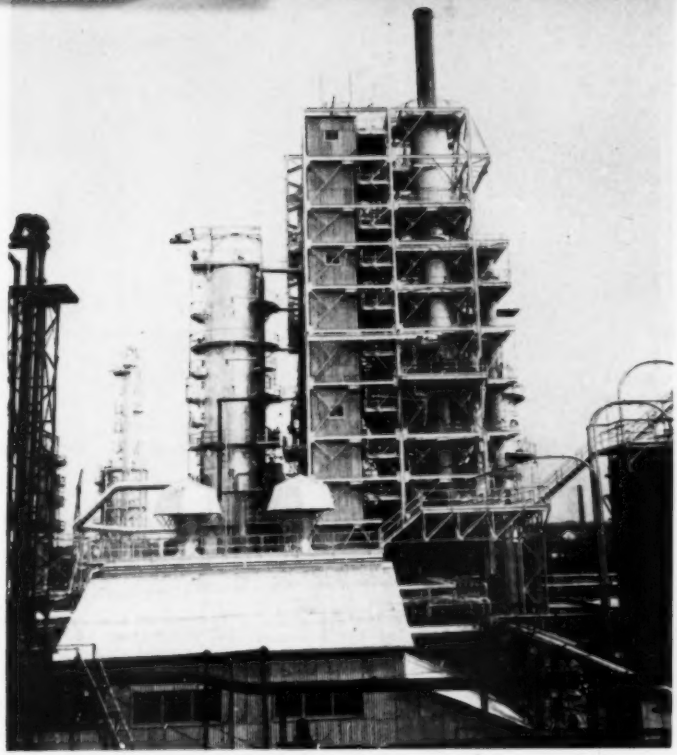
The stand, or support, for the box is a regular laboratory type double ring-stand. A piece of ⅛-inch boiler plate 8 inches by 10 inches is welded to the uprights at the bottom and on this plate are mounted a type 200-CM 115-volt Variac, a switch and an indicator light.

An electric stirrer is attached to each of the two uprights of the ring stand, connected to a glass auger-type stirrer by means of a short length of rubber tubing and adjusted in such position as will give smooth operation. A spring-type test tube clamp is attached to each upright in such a position that the jaws of the clamps are just above and centered over the 1⅛-inch diameter holes. The entire apparatus is finished with blackboard slating paint. Figures 1 and 2 are photographs showing two views of the apparatus in position in the testing laboratory. Figure 3 is a detailed sketch of the apparatus. Various modifications of this model are possible, and the selection of materials of which the equipment is built is likewise optional, depending on local conditions.

In operation, the test tube containing the oil-aniline mixture is suspended into the interior of the box by means of one of the spring-type clamps attached to the ring-stand. The stirrer and thermometer are placed in the test tube just as in the ASTM procedure and the electric stirrer is started. The tester then applies heat to the test tubes. The rate of heating is in proportion to the current emitting from the Variac. The oil-aniline mixture can be heated at rates as high as 25° C. per minute until a point slightly above the temperature of complete miscibility is attained. The instant the voltage is reduced to zero no more heating of the mixture takes place and the tester controls the cooling rate by proper adjustment of the Variac. Heat may then be applied gradually until a point above the temperature of miscibility is again attained. This operation may be repeated as many times as the tester deems necessary to accurately determine the cloud point. When the test is completed the tester reduces the voltage to zero, removes the test tube and replaces it with one containing another sample-aniline mixture. A tester may run two aniline numbers simultaneously with this apparatus by determining the cloud point of the lower aniline number sample and leaving it in position while raising the temperature to determine the cloud point of the second sample.

Figure 3. Detailed Sketch of the Aniline Point Determination Apparatus Showing Arrangement, Etc. of Apparatus.





First Unit of Lima Expansion Now Completed

At left—The big cat cracker of The Standard Oil Company (Ohio) at its refinery in Lima, Ohio, which will run 16,000 barrels per day of gas-oil. The unit is highly automatic, requiring a crew of only six men per shift. The 195-foot structure is the tallest structure in the state.

FIRST unit to be completed in the $30 million expansion and modernization program of The Standard Oil Company (Ohio) at its refinery in Lima, the new $11 million catalytic cracking plant was formally dedicated October 19. Arthur C. McKee & Company of Cleveland was the builder.

The expansion program will double the refinery's present capacity. S. R. Bolles is refinery manager.

The new catalytic cracking plant, which will run 16,000 barrels per day, embodies the most modern design and is expected to produce 30 percent more gasoline per barrel of crude oil. Highly automatic, the new cat cracker requires a crew of only six men per shift. Valves which in other units have been turned by hand are here hydraulically powered and operated by push buttons in the control house.

Monorail hoists have been built into every level of the structure to lighten physical labor and greatly reduce the amount of time required for a turnaround.

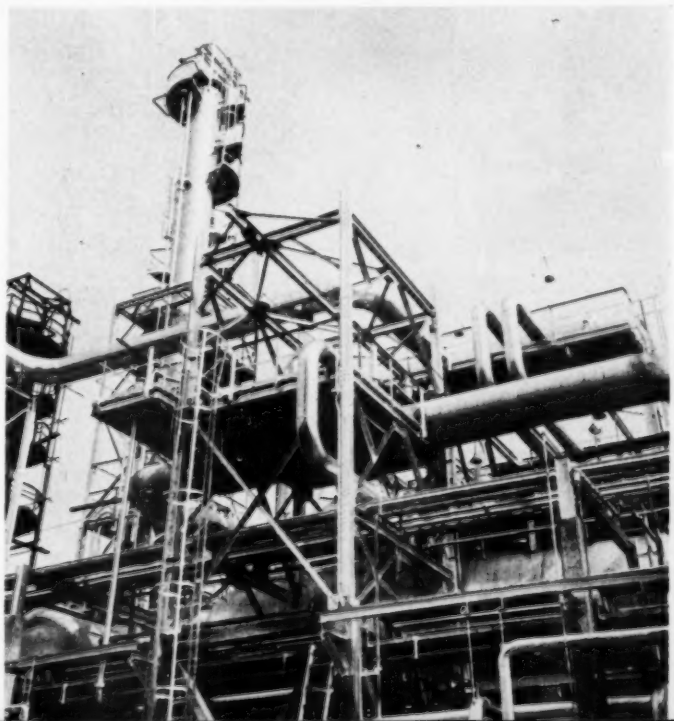
Atop the cat cracker is a silencer to reduce the noise created by flue gas escaping into the atmosphere. The vessel is 10½ feet in diameter and 31½ feet long.

The second big unit in the Lima expansion program is the continuous crude distillation and coking unit, one of the first of its kind in the nation. This unit costing $5.5 million is expected to go into service early in 1950.

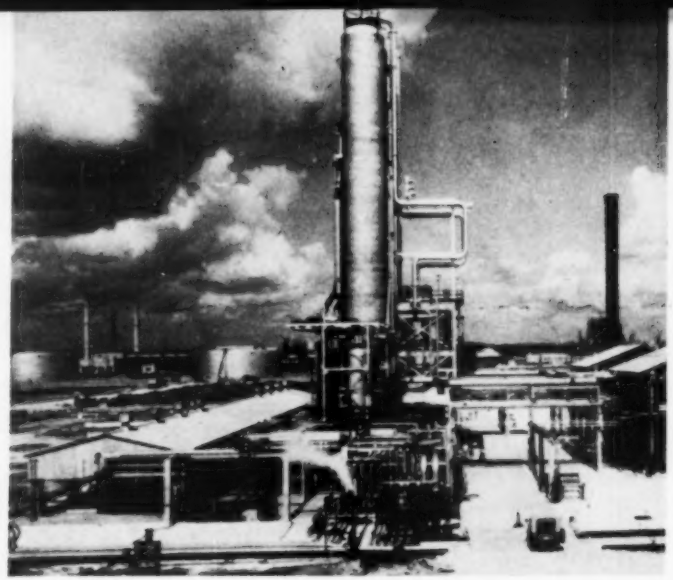
The third big unit is the $13,628,000 solvent refining plant which will more than double Sohio's existing capacity for the production of lubricating oils. It is expected to begin operations during the summer of 1950.

Also included in the expansion is new tankage totaling 200,000 barrels, to cost $240,000; a new liquid gas plant, to cost $225,000 and a new office building and laboratory.

Below is another view of the plant undergoing the $30 million expansion program.



Cit-Con's "twin" vacuum distillation units shown here (part of view shows on page opposite). Each handles 12,500 barrels a day of reduced crude. Design provides overcapacity to permit producing a higher proportion of neutral oils to bright stock when required. →



Cit-Con's New Lube Plant Is Opened At Lake Charles

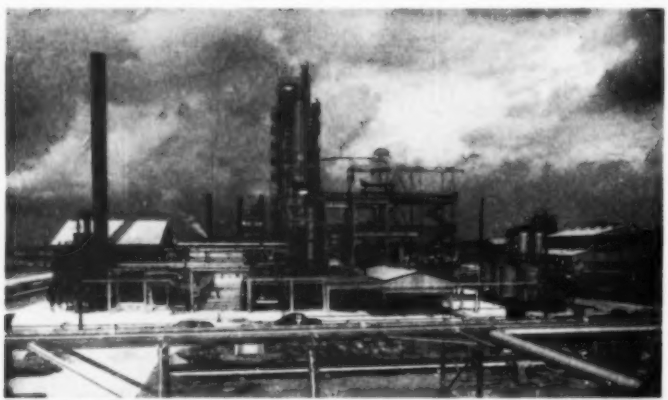
WITH all units completed and running, the new $40 million Cit-Con Refinery—called "the most modern lubricating oil plant in the world"—has begun full operations at Lake Charles La.

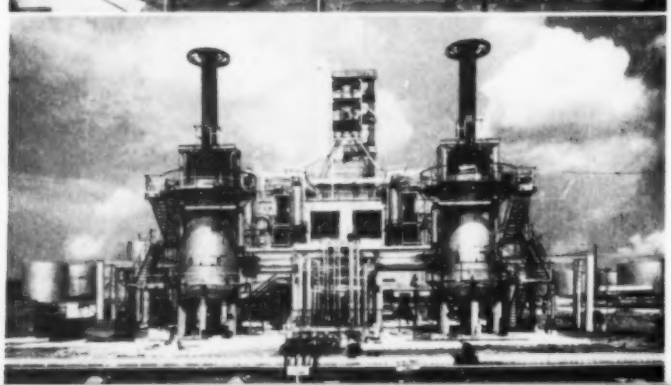
The plant is owned by Cit-Con Oil Corporation, which was formed by Cities Service Company and Continental Oil Company for building and operating the refinery. All units of the refinery were designed and constructed by the Lummus Company, New York, with the exception of the Duo-Sol plant which was designed and constructed by Max B. Miller Co. The Lummus-built units consist of two vacuum distillation units, a furfural unit, two MEK dewaxing plants, two clay contact plants, wax finishing and wax slabbing plants, as well as the laboratory, offices, change house, steam plant, and shops.

Output of the refinery, at peak operation, is 2,072,000 barrels a year, or, on a daily basis, 6000 barrels of high-quality solvent refined lubricating oils, and more than 1500 barrels of fully refined paraffin wax and microcrystalline wax—or about 15 percent of the nation's total production of wax. Top supervisory personnel have been drawn equally from Cities Service and Continental Oil. Production of finished stocks is divided between the two oil companies, with Cities Service receiving 65 percent and Continental 35 percent for disposal through their respective marketing outlets.

It is significant that Cit-Con is a completely new project, all units engineered and constructed from the beginning to conform to a well developed pattern, rather than individual units being added to supplement old, existing installations.

Outstanding among the many engineering innovations introduced in the design and construction is the construction of the two vacuum distillation units, designed as "twin" units with some overcapacity to permit producing a higher proportion of neutral oils to bright stock when required. This provides flexibility and continuity of operation, and each unit can handle 12,500 barrels a day of reduced crude. The units will produce close-cut lube distillate fractions which





Top photo at left—The furfural extraction unit is the largest ever built, with two stages of furfural recovery on the raffinate system and four stages on the extract system. The solvent circulation rate is set at 50,000 barrels daily.

Lower photo—These vertical heater distinguish Cit-Con's two identical clay contact plants. One handles light distillates; and the other, heavy distillates and bright stocks.

will not require re-running for viscosity control.

Special arrangements to assure a uniform charge stock in each tank, thus overcoming possible stratification of various types of reduced crude, are provided in three 80,000-barrel charge tanks, each equipped with two 25-horsepower propeller-type agitators to mix the tank contents. As each tank supplies total charge for nearly four days, operation is simplified and quality control improved.

The fractionator column of each unit measures 114 by 13 feet, and is equipped with "shower" trays, except for conventional bubble decks for the top tray, the two trays above the charge inlet, and several in the residuum stripping section. Such design permits a smaller diameter tower and reduces over-all pressure drop. The "shower" tray installation divides the descending reflux into thousands of small streams through which the upcoming vapors must pass. Besides a lower pressure drop and reduction in tray area for a given charge rate, another advantage, compared with bubble decks, consists of a substantially increased vapor velocity, without danger of flooding.

The vacuum distillation units also use an oil separation tank to minimize oil losses in case a small amount of gas oil is carried overhead.

The furfural extraction unit—termed the largest ever built—is conventional in basic design, but features a number of technical refinements. Among these, the solvent circulation rate has been set at 30,000 barrels a day and recovery equipment designed accordingly in order to permit the same charge rate from both 95 and 100 V.I. operation. Four stages of solvent recovery are used on the extract phase, in comparison to three as in some furfural units, and such a large volume of solvent is handled that a heater, absorbing 72 million Btu's an hour is required to evaporate solvent in the charge to the pressure flash chamber.

The MEK solvent dewaxing process comes after the solvent refining of all raffinate stocks, because it was found that to dewax after solvent refining is less expensive, and that the produced wax contains a higher quality oil if first solvent refined, thus simplifying the job of treating the wax to the "fully refined" state. No. 1 MEK dewaxing, which handles the three lightest distillate stocks, features a recrystallization system, and is designed to permit modification for incremental dilution in the future. Four vacuum filters remove the wax. No. 2 MEK, which handles the heavy intermediate distillate and bright stock, has six primary filters. A central propane refrigeration system is used to take care of the refrigeration requirements of the two dewaxing plants.

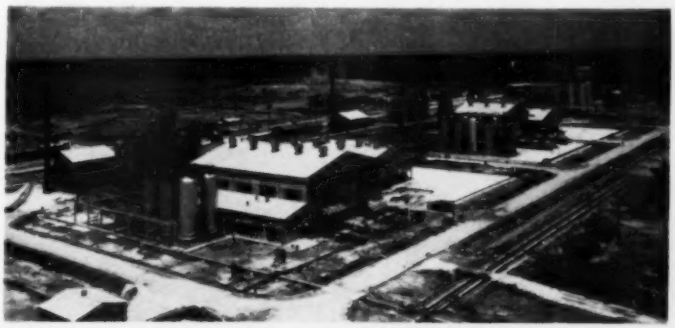
Two identical clay contact plants provide clay treatment of all dewaxed oils to achieve improved color and stability. Clay is stored in two 225-ton hoppers, and is handled to and from storage by air conveyors. The clay dosage is controlled by a mechanical feeder. In the wax finishing plant, only crystalline paraffin waxes will be treated, with the various grades of waxes treated first with sulfuric acid in two 800-barrel batch agitators followed by percolation filtration with bauxite.

To dispose of acid sludge resulting from acid treatment, Cit-Con dumps the molten material into an insulated trailer equipped with steam coils when re-heating becomes necessary. When this trailer is full, it is hauled to the nearby Cities Service refinery where material is blended with spent alkylation sulfuric acid and charged to Cities Service sulfuric acid plant for recovery.

Equipment in the wax slabbing building permits manufacture of 10-pound slabs for shipment, loose or in cartons. Six moulds in the building each produce 240 slabs. A warehouse for wax is in the same building. Most of Cit-Con's bulk of wax production will be held in "unfinished" stage, with finishing done only as shipping orders require. This will preclude any possibility of oxidation because of long storage in molten state.

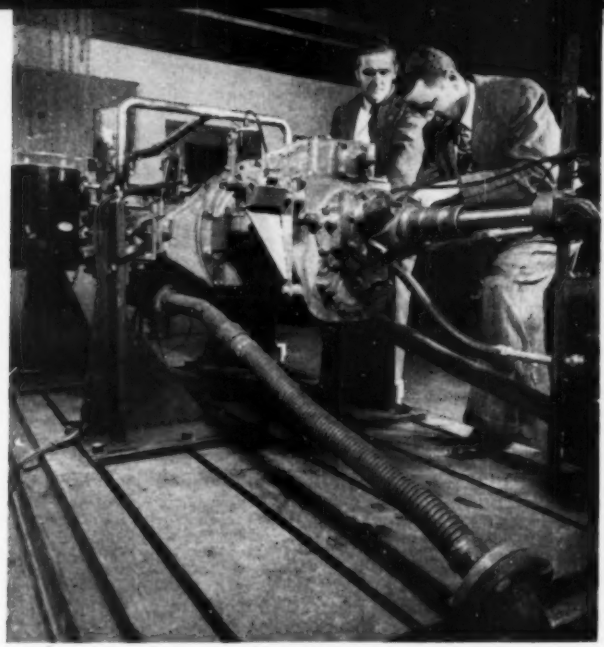
The laboratory is furnished with equipment for both routine and control tests, as well as for experimental investigation in furfural extraction, clay contacting and wax percolation, batch experimental vacuum stills, and deasphalting. An MEK dewaxing unit is also provided to permit special studies of dewaxing problems.

This general view shows, from left to right, MEK dewaxing units No. 1 and 2, and the clay contact plant. The two MEK plants were so designed that the plant for light distillates has recrystallization facilities and later may be equipped for incremental dilution. The other plant for heavy intermediate distillate and bright stock, is presently equipped with repulping facilities to reduce oil content of the amorphous type wax to which recrystallization can be added in the future.



This air view shows the L-shaped layout of the Cit-Con processing units. From right to center foreground can be seen, in order: vacuum distillation units, solvent refining units, and the steam plant with three smokestacks. Continuing to the left around the L are the two MEK dewaxing units, the clay contact plant, and the wax finishing unit.

New Hydraulic Fluid Laboratory At Wood River



A torque converter, newest type of fluid drive for cars, is shown in the two pictures being used by these Shell Oil Company scientists to test hydraulic fluids. High specification fluids are needed to transmit power in the torque converter because of the pressures and temperatures developed during operation of the unit. Designed to eliminate gear shifting and provide a smooth flow of power at all speeds, the torque converter is expected by many to be standard equipment for most cars within five years.

THE likelihood that fluids may be used to transmit virtually all power in cars of the future was pointed out by F. S. Clulow, Shell Oil Company vice president in charge of manufacturing, as he announced the recent opening of a new hydraulic fluid laboratory at the company's Wood River, Ill., refinery.

"Since fluids can be made to supply a smooth power source for any job that is now done mechanically, there is a tremendous field for the application of hydraulic power in automobiles, aircraft and industrial machines," he said. "This laboratory is intended to develop fluids for such needs."

With automobile brakes and transmissions being operated hydraulically, Clulow added, "there is reason to believe that fluids may eventually be used to operate built-in jacks, to power steering mechanisms, and to raise and lower tops, hoods, and windows." Other possible uses include the operation of constant-speed generators and of temperature-regulating devices. The first would extend battery life; the second would prolong engine life by insuring adequate temperature control during cold weather, light-load operation as well as in sustained driving at high temperatures.

The need for continued research in hydraulics "because of the wide and growing use of fluid power in both aviation and industry," also was stressed. Landing gear and controls on large planes are already operated hydraulically, and hydraulic drives are used to transmit power in many industrial machines. The demand for new and improved types of fluid is expected to grow as machine designs change in the future.

Shell's new laboratory, housed in a specially constructed building, "is the latest step in a program the company began about ten years ago for the purpose of developing fluids for the increasing number of hydraulic systems coming into use," the vice president declared. "The building and its equipment meet the need for special facilities in developing and testing hydraulic fluids, which must be made to extremely rigid specifications."

You too can give your jobs that extra punch by taking advantage of Master's unusual ability to give you the RIGHT horsepower, the RIGHT shaft speed, the RIGHT construction features, the RIGHT mounting . . . all combined into one compact power package.

Don't put up with make-shift assemblies when you too may be enjoying these advantages. Master motors, available in millions and millions of types and ratings (up to 150 HP) give you a selection you can get nowhere else.

Give them the old "one-two" punch

Open, enclosed, splash proof, fan-cooled explosion proof . . . horizontal or vertical . . . for all phases, voltages and frequencies . . . in single speed, multi-speed and variable speed types . . . with or without flanges or other special features . . . with 5 types of gear reduction up to 432 to 1 ratio . . . with electric brakes . . . with mechanical variable speed units . . . and for every type of mounting . . . Master has them all and so can be completely impartial in helping you select the one best motor drive for YOU.

Select the RIGHT power drive from Master's broad line and you can increase the saleability of your motor driven products . . . improve the economy and productivity of your plant equipment.

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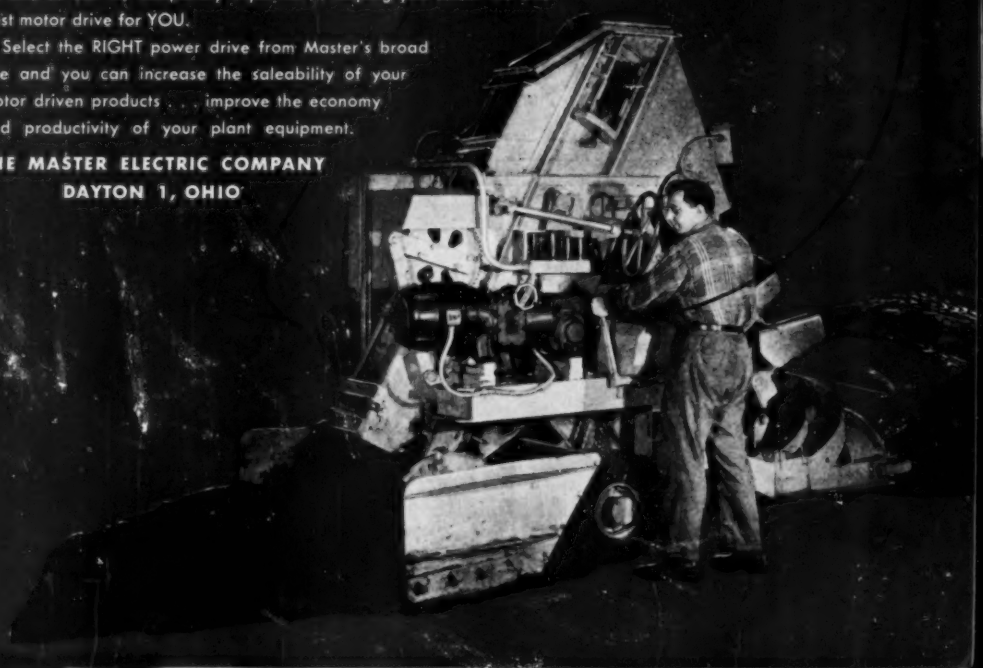

Cleaning *any* tube is a *Lagonda* job . . .

LARGE TUBES

Use the Lagonda 1100 Series cleaner, favorite on still tubes since it was first developed. Ball bearings at both ends take up thrust both ways. Positive lubrication at front bearing as well as rear. All in all a motor that has reserves of power to handle the toughest coke with an assortment of cutter heads adapted to any condition. *Write for the Refinery Tube Cleaner Bulletin.*

SMALL TUBES

Short-bodied air-driven motor with flexible holder and scraper head, for curved tubes. This head for soft, light scale, or gummy, oily deposits.

Long flexible holder with expanding brush, for light deposits in curved tubes.

Long-bodied motor with universal joint and single-pin head, as used in straight tubes. This head for heavy deposits.

Flexible holder and circular brush on air-driven motor, as used in cleaning curved tubes.

Long-bodied motor with direct-connected scraper head, for straight tubes.

Water-driven motor. This motor can be used with all the attachments shown here.

Expanding brush, flexible holder, for curved tubes.

Small, long-bodied motor, flexible holder, with scraper head.

Threaded cone cutter, flexible holder, for small straight tubes.

The above cleaners fully described in the Small Tube Cleaner Bulletin.

ELLIOTT COMPANY

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SPRINGFIELD, OHIO

DISTRICT OFFICES IN PRINCIPAL CITIES

Lagonda

TUBE CLEANERS FOR REFINERIES

Y-292

REFINER AUTHORS and Other Personalities

Information, formal and otherwise, about the men who write for PETROLEUM REFINER as well as others prominent in the industry.

Globe Men Are Good Scouts

"The Determination of Inorganic Chlorides in Crude Oils," page 121, places in black and white some information that a number of **PR** readers will be very pleased to see. The chief and assistant chief chemist of Globe Oil & Refining Company, W. F. Krause and A. C. Dystrup, respectively, contributed the article.

Krause, a native of Minnesota, attended Macalester College, St. Paul, where he majored in chemistry at The University of Wisconsin he received his master's and Ph.D degrees, majoring in inorganic and minoring in organic chemistry.

He joined the Globe organization in 1934—research chemist. Four years later he was promoted to chief chemist (1938). Krause is treasurer of the village of Lemont, Ill., where he also engages in Cub Scout work. Next on his hobby list are gardening and carpentry. Married in 1932, he and Mrs. Krause are parents of twin sons, Robert and Paul—age 11, and four-year old daughter Janet.

Dystrup earned his athletic letter as a quarter-miler at the University of Chicago where he received his bachelor of science degree in chemistry. After graduating Dystrup returned to his home town of Lemont, Ill., where he was born in 1914. Lemont is also the location of Globe Oil & Refining Company, which Dystrup joined as an analytical chemist on the laboratory staff in 1937. Three years later he became assistant chief chemist.

Dystrup likes music, travel, and practically all sports. He serves as scoutmaster of Troop 49 of Lemont.

The Dystrup's have two sons, Andy and Dick, ages 4 and 6.

Safety Engineer On Flammable Liquids

Don Attaway ("Safe Practices in Handling Flammable Liquids," page 117) is a native Texan now residing in Shreveport, La. He began his career in January, 1923, with Dixie Gulf Gas Company as a timekeeper, later was promoted to the payroll department of United Gas Company, and joined Arkansas Fuel Oil Company in 1929.

In 1940, he combined the duties of a safety engineer with his responsibility as superintendent of measurement and has been conducting the safety activities of his department, which includes personnel and operation of 12 natural gasoline plants located in Arkansas, Louisiana, and Texas.

Attaway has completed extension courses in gas engineering, petroleum safety, and plant protection and is vice chairman of the petroleum section of the National Safety Council. Presently he is a member of the API's Natural Gasoline Accident Prevention Committee.

Reading, writing, and play acting constitute Attaway's hobbies. He has been an active member of the Little Theater of Shreveport for the past 10 years and has appeared in many of its productions.

The Attaway's have two children—a boy and a girl.

Houston Business Keeps Ex-Flyer Busy

Flying is still his great delight, but Dwight J. Evans who makes his debut in **PR's** columns as author of "Recent Development in the Measurement of Metal Thickness from One Side," page 109, admits that as a hobby, his flying has been pretty much grounded since he came south in February from Stamford, Conn. to open a Houston branch of Branson Instruments, Inc. Before joining the company in 1948, he was employed with Phillips Petroleum Company, Bartlesville, Okla., in the engineering department in the study of electrolytic corrosion and electrical instrumentation problems. He was on military leave, 1943-5, serving as radar officer with the navy, which probably accounts for his present love of the clouds. He is a graduate in electrical engineering from Kansas University. Evans claims that Houston's activities have not kept him entirely isolated from another interest, namely photography, which he also rates as a very chief pastime.

Re Old Mansions

Tyler Hicks, ("Power Plants for Modern Refineries," page 113) says that preliminary selection of heaters is only a short-cut, never a substitute for manufacturers' calculations. Hicks is a frequent contributor to **PR.**

To get away from heaters, Hicks recently acquired one of those ancient "mansions" which one reads about. This one has 14 rooms but the most important

Cameron Dystrup | W. F. Krause | Dwight Evans | Don Attaway

C. W. Shelley

E. Holley Poe

Roy W. Osburn

Robert G. Blick

one was missing until he took over. A plumber handled that matter rather quickly. After some intensive study of each of the rooms, Hicks says: 1) try to count the number of paint layers on any given woodwork before buying one of these mansions. Figure ten years per layer and you've got the age of the house. His had eight. 2) Watch for wooden shingle roofs. You can sometimes see the sun better through the spaces between shingles than you can from the ground. 3) When the well runs dry, don't head for that favorite cabinet of yours. Just wait until it rains.

Conclusions: It's plenty of fun and work. Try it and see.

Hard Decision Hobbies Vs. Work

Robert G. Blick, author of the article, "Pipe Supports and Pipe Restraints," page 128 entered the refinery design field in 1942 with The M. W. Kellogg Company and stayed with them until 1946, except for an interlude in the armed forces as a radio-theory instructor. After leaving Kellogg, Blick joined Project Engineering Company as head of the piping stresses group. At present he is with the stress analysis division of Lockheed Aircraft Corporation of California.

Blick likes to refinish old furniture and design sound amplifiers for a hobby, and goes in for disc recording. In the past he has "fooled around" with the design of specialized radio apparatus, such as watch timers and electronic computers. Now he is writing a paper on a new type of feedback amplifier. While in the Army he designed several pieces of Signal Corps equipment.

Married and the father of three daughters, 5½ and 2 years old and 5 months old, he met his wife while both were studying at Cooper Union—his wife in the art department. If his two older daughters have anything to say about it, kite-flying and fishing soon will be included in Blick's hobbies.

Sherwood Starting Eight-Part Series

Peter W. Sherwood, Koppers Company, Inc., Pittsburgh, makes his third apperance among **PR** authors with the first of eight installments of "High Pressure Hydrogenation of Carbonaceous Matter," page 97. Previous articles were "Acetylene from Petroleum Gas," and "Ethylene Glycol via Ethylene Chlorohydrin."

Sherwood was graduated from Columbia University with a master's degree in chemical engineering and continued his studies at Brooklyn Polytechnic Institute and the University of Pittsburgh. He has been associated with Koppers since 1943. As a process engineer he is concerned with the technical and economic evaluation of various chemical processes and the design and estimating of chemical and fuels plants. He spent about a year on a Koppers Fellowship at the Mellon Institute of Industrial Research.

In 1945, Sherwood joined the Technical Oil Mission to Germany and was assistant chief of the fuels and lubricants unit of field information agency, technical. He recently published "High Pressure Hydrogenation in Germany," a monograph on German coal liquefaction technology.

Sherwood is fond of chamber music, which is his favorite hobby. Also, he is interested in golf and photography.

A Touch of Texas

Roy W. Osburn, whose article "Soil Pressure Under Foundations," begins on page 123, is a member of Koch Engineering Company, Inc., Wichita, Kan.

Osburn was born in Kansas admits to being reared in Texas, and went to work in Minnesota after receiving his degree in engineering from the University of Minnesota in 1927.

Before joining Kock, where he is concerned with refinery process design work, Osburn worked mostly in the manufacturing field with design and special tooling problems. Also, he was involved for short intervals in adult education along engineering and allied lines. He is an active member in several technical societies in Wichita.

For diversion, Osburn indulges as an amateur mineralogist and geologist and as a member of the local coin club.

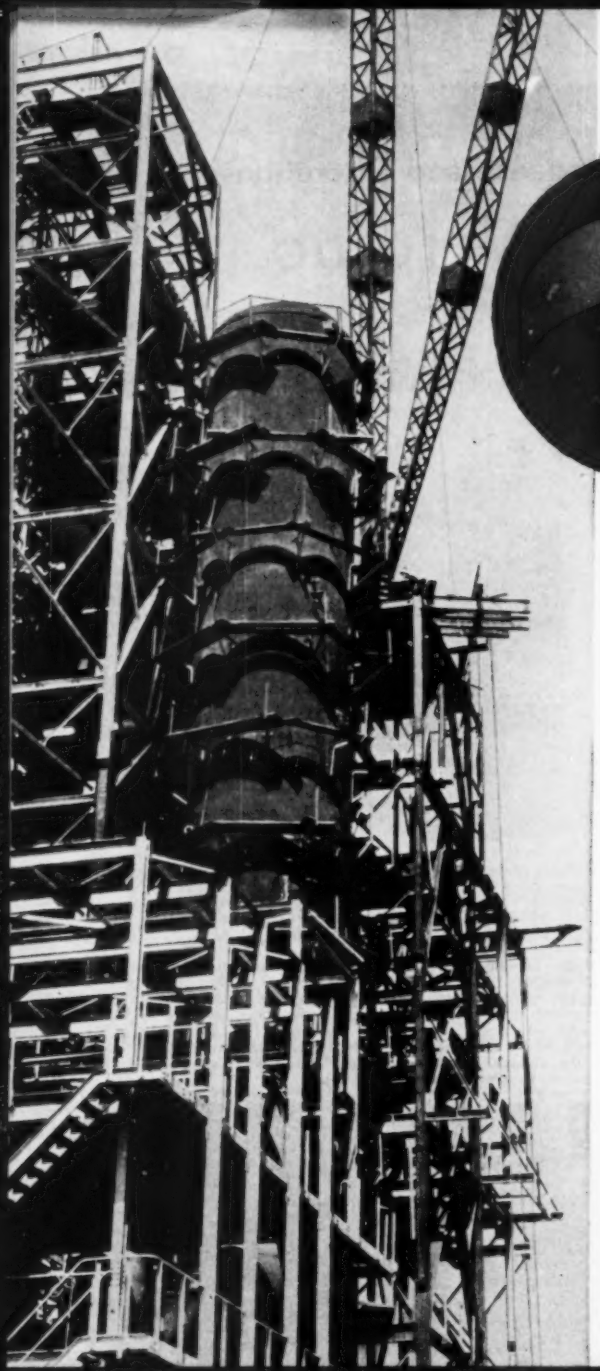
Golfer Is Looking For An Easy Match

Native Texan, Charles W. Shelley, who wrote, "Determination of Aniline Point Using Infrared Heating Lamps as the Source of Heat," the article beginning on page 147 of this issue of PR, is looking for someone he can beat at golf. Shelley is not looking for someone he can beat consistently at his weekend hobby, but at least occasionally. Actually, he is a pretty good golfing engineer. The Shelley's have two daughters.

Hailing from Bell County, Shelley attended Temple Junior College at Temple, Texas, then attended Texas A. & M. College at College Station. He joined Magnolia in 1936 at Beaumont, Texas, has been engaged in experimental laboratory work for the past seven years. Presently, he is on the staff of Magnolia's new process control laboratories.

Natural Gas Expert

No stranger to the gas and oil industries is E. Holley Poe, author of the article appearing on page 135, entitled "The Coming Impact of Natural Gas on the Fuel-Oil Market." Poe, a native of Oklahoma, is former head of the natural gasoline department of the American Gas Association. In 1942 he became director of PAW natural gas and natural gasoline division and in 1943 was elected executive vice president of Petroleum Reserves Corporation. He is also head of the firm of E. Holley Poe and Associates, New York.



UP AND IN PLACE
...on schedule

THE date for this particular stage of construction was determined months ahead of time. Each phase of McKee refinery engineering, procurement and construction is scheduled to coordinate with the next and to proceed in a minimum of time. Every McKee facility is employed to maintain or exceed that schedule. This takes experience, planning and *organization*, but it saves time and money. That's good for your business—and ours too.

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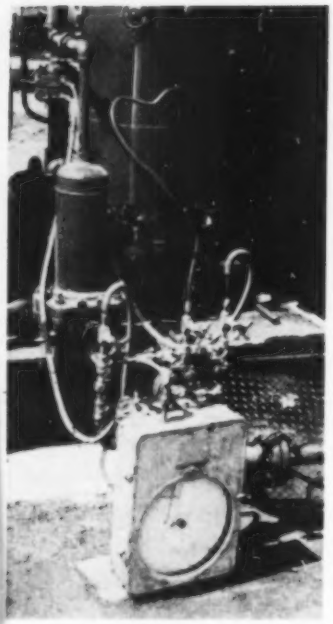
Maintenance and Operation—

HOW TO DO IT

HOW TO—

Check Fuel Consumption

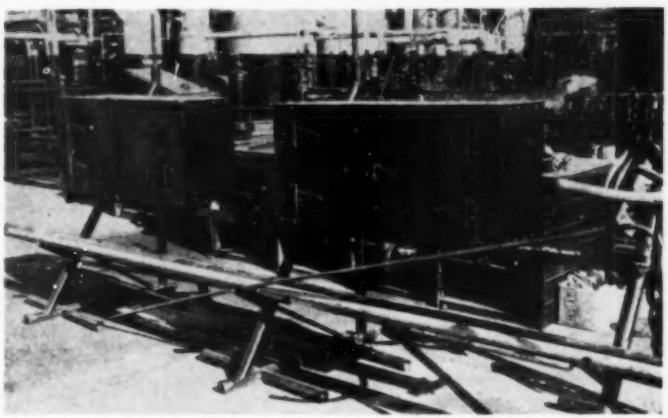


Portable flow meter used for checking fuel gas consumption of compressor engine. The instrument case is attached to a steel base plate, which serves to keep the instrument upright. Levelling of the case is accomplished by wedging beneath the base plate.

HOW TO—

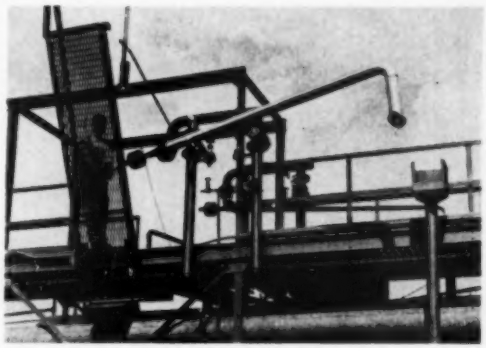
Make Job Equipment Unit

ON SOME maintenance work it is convenient for the crew to be supplied with tools and boxes which need not be hauled to the warehouse each night. To provide this convenience, a maintenance supervisor designed weather proof tool boxes in which small tools can be safely stored. The boxes are all steel, riveted and welded and provided with double swinging doors hung on T-hinges. The doors are equipped with locks so personal tools can be left while the workmen are away. The boxes are mounted on a set of supports designed to store current stocks of small pipe which might be required on the job. The supports are made with a tool box base consisting of a piece of wide channel iron, with the channel up, in which small fittings can be placed instead of laying them on the ground. The standards for the supports are made of pipe connected to footing, also of pipe, with cross members at right angles to afford stability. The standard at the back is vertical while the standards at the front of the boxes are used to form a pipe rack.



HOW TO—Expedite Car Loading Aluminum Swing Line

RECENTLY, at The Ohio Oil Company's 30,000-barrel-per-day refinery near Robinson, Ill., the filling of tank cars has been expedited and worker fatigue lessened by the use of a newly designed all-aluminum swing line. It is 12 feet in length, 4 inches in diameter and fabricated with aluminum welding fittings. After being fabricated the line was counter weighted. The discharge end of the line is equipped with a tee, so that the oil is directed to both ends of the tank, adding considerably to filling efficiency. Weight of the all-aluminum assembly is approximately 42 pounds. Had it been fabricated in the conventional way, with carbon steel pipe and fittings, it would weigh approximately 129 pounds. And it would require correspondingly greater physical effort to maneuver.



The aluminum pipe and aluminum fittings used in the new swing line are of 3S-F alloy. The shop fabricated joints were welded by the argon gas shielded tungsten arc method.

Photograph and material courtesy Tube-Turns, Inc., Louisville, Ky.

CUT MAINTENANCE COSTS
with permanent insulation

This photo shows how PC Foamglas is used to insulate tanks and pipe lines. The material is available in standard flat blocks, curved segments and beveled tags to fit equipment sides, heads and domes, and in preformed sections for standard pipe sizes and fittings.

● It takes a mighty effective insulating material to maintain the precise temperature controls demanded by your processing operations. And it takes a mighty trouble-free material to keep your maintenance costs down to rock bottom.

PC Foamglas has long since proved its ability to maintain high or low temperatures, indoors and out. It has met all tests successfully . . . on tanks, towers, retorts and other large vessels . . . on piping and fittings . . . on heat exchangers, evaporators and other processing equipment . . . in a wide range of industries.

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Our insulating specialists will be glad to consult with you upon request, to find out just how you can save money on maintenance with PC Foamglas. Meanwhile, why not send the coupon for our new booklet about typical uses of Foamglas and a sample of the material—today?

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The entire strong, rigid block is composed of millions of sealed glass bubbles. They form a continuous structure, so no air, moisture, vapor or fumes can get into or through the Foamglas block. In those closed glass cells, which contain still air, lies the secret of the material's permanent insulating efficiency.

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HOW TO—

Apply Insulation in All-Metal Building

HOW thermal insulation and acoustical problems encountered in all-metal structures can be solved is illustrated by a factory-fabricated, job-erected, all-metal building recently completed at Sun Oil Company's Toledo, Ohio, refinery. The possibility of rapid erection, combined with low initial and maintenance costs, is making this type of building increasingly popular for a wide variety of industrial and commercial uses.

The one-story structure at the Sun Toledo refinery has sheet aluminum walls and roof, and is 640 feet long by 40 feet wide. At the present time, while a large-scale construction program is under way at the refinery, the building is being used as a craft shop and tool crib. When the construction program is completed it will be used as a warehouse.

Since aluminum conducts heat with great rapidity—the rate of conduction is nearly 5000 times faster than through insulation—proper insulation was of prime importance both to prevent overheating of the interior during the summer, and to permit economical heating by steam unit heaters during the winter months. Since performance and cost were primarily the governing factors, an insulation of light-density, two inches thick, unfaced and unpainted, was applied to the walls and roof by a low-cost, rapid method. The insulation was installed by Service Products, Inc., Toledo, and the entire installation was completed by a crew of nine men in less than three weeks.

Noise reduction was not a factor in the Sun Oil all-metal building, but the insulation employed has a high noise adsorption efficiency, making it possible to provide both thermal and acoustical treatment with one application of a single material. In another similar installation an 85 percent reduction in noise was achieved.

Photographs and material courtesy Owens-Corning Fiberglas Corporation, Toledo, Ohio.

PHOTOS

Top Photo — Mechanical fasteners, or clips, were adhered to the walls with standard adhesive on 12-inch centers, horizontally. Vertically, three clips were spaced at an equal distance between the girts, which are 65 inches apart.

Center Photo — The insulation was impaled on the prongs of the clips, and the prongs were bent back flush with the insulation surface.

Bottom Photo — Insulation was applied to the roof by using wooden strips attached to the steel beams, which in combination with fasteners applied on top of the insulation, hold the insulation firmly in place.

Photos of men at work, used as a decorative piece in the heading for this section and the "How To Do It" pages of the November issue are being used through courtesy of The Stanocolan, an Esso Standard Oil Company publication.

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Nos. 1-12

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REFINER

SPECIALIZED FOR REFINING, NATURAL GASOLINE AND PETROCHEMICAL ENGINEERING, OPERATION AND MANAGEMENT

A Gulf Publishing Company Publication

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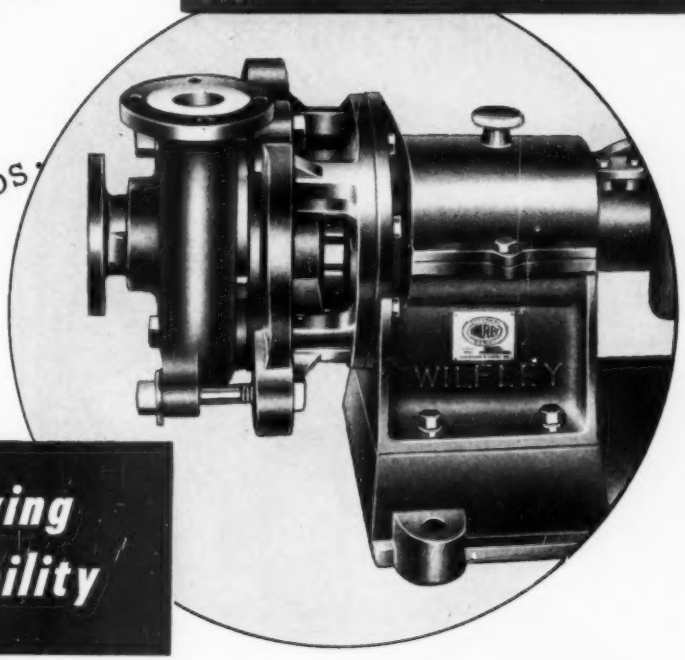

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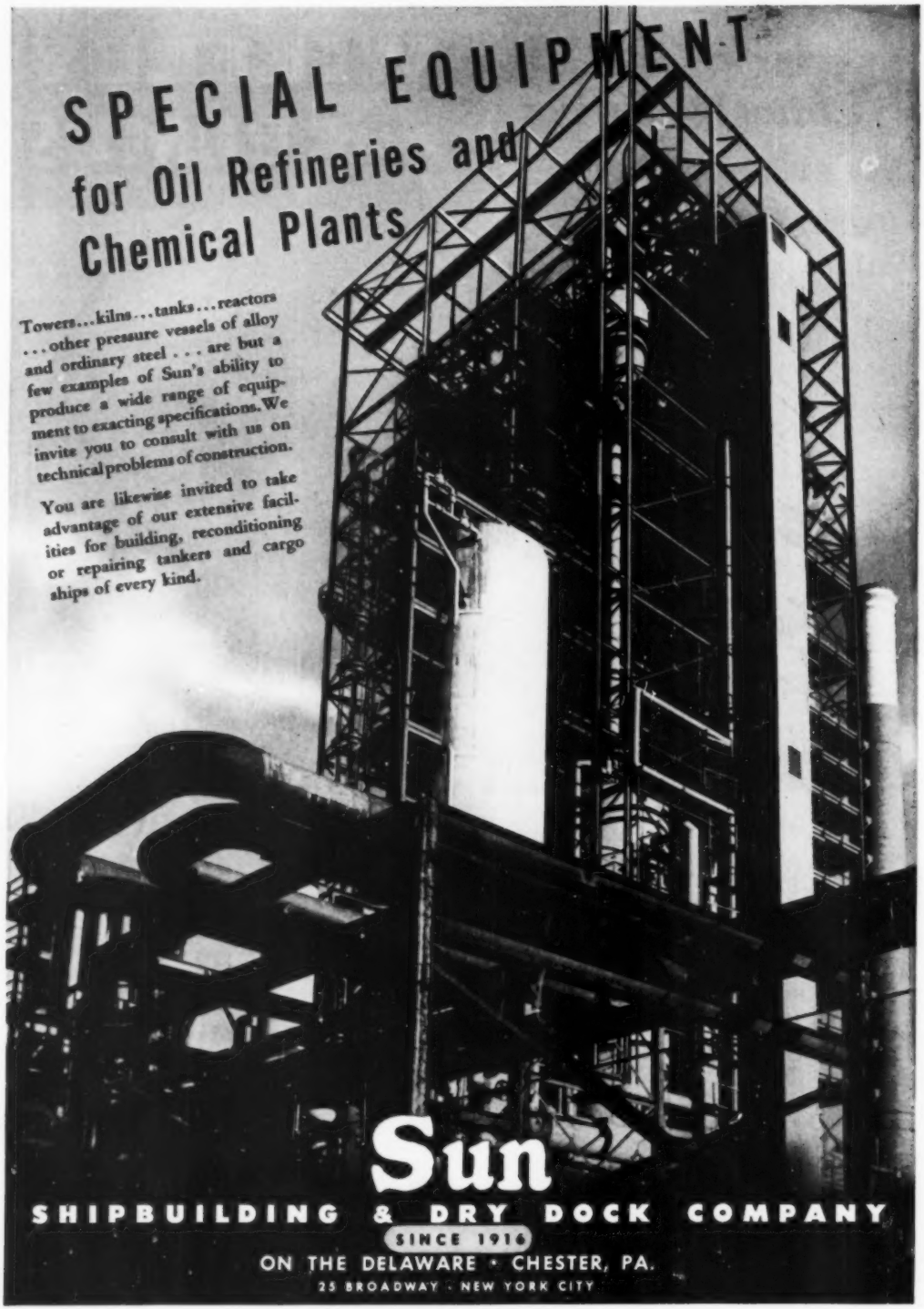
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THE MONTH in the INDUSTRY

Receives ASM Medal

One of the country's top research honors—the 1949 medal for the advancement of Research—was presented at the annual banquet of the American Society for Metals to Fred H. Haggerson, president of Union Carbide and Carbon Corporation for his example as an industrial leader who has "advanced technological progress in broad fields of the metal industries to the ultimate benefit of the consuming public."

Haggerson

Haggerson has been associated with Union Carbide and Carbon Corporation for 30 years and was elected president of the corporation in 1944. He is the seventh industrial leader to receive the medal since its institution in 1943.

Plant Passes Millionth Accident-Free Hour

Phillips Chemical Company's Cactus plant, near Etter, Texas, passed its millionth man-hour without a lost-time accident last month, according to K. S. Adams, president of Phillips Petroleum Company and its wholly-owned chemical subsidiary.

This record was established over a period of 391 calendar days, the last lost-time accident having occurred on October 22, 1948. Cactus plant produces anhydrous ammonia from natural gas and a safety record of one million man-hours is especially outstanding for a plant of this type which has approximately 450 employes.

Texaco Research Scientists Standardize Lab Equipment

At their Beacon, New York research center, Texaco scientists have established a centralized Bureau of Standards that performs many of the same services for The Texas Company that the National Bureau of Standards performs for the U. S. Government. Not only does this department standardize Texaco laboratory equipment for 20 refinery and 17 terminal laboratories throughout the world, officials said, but it is also responsible for the initiation of new and improved test methods.

Experts in the field of standardization make annual tours to insure that the 37 laboratories all conduct the multitude of standard inspection tests identically in all respects. Sixty thousand pieces of equipment are checked each year including knock-rating engine operations, high and low temperature fractional distillations, mass spectrometer and infrared analyses. Identical samples of commercial petroleum products are shipped periodically to other laboratories so that they may independently check on the accuracy of their test results.

Aries & Associates Open Stockholm Office

A branch office of the New York consulting engineering firm of R. S. Aries & Associates has been opened in Stockholm, Sweden. The new office, headed by Sven Telenius, will handle consulting work in the Scandinavian peninsula. Telenius is a graduate engineer of the Royal Institute of Technology and has had long experience in the chemical process industries.

The new office will coordinate the work on new product development, process design and sales development of the New York firm. The address of the branch office is P. O. 3260, Stockholm, Sweden.

LPG Committee to Study Liquid Oil Gas Situation

Walter S. Hallanan, chairman of the National Petroleum Council, has announced the appointment of a 1949-1950 committee in response to a request by the Department of the Interior for a study on the LPG situation, including its production and transportation. The committee's study will be submitted to the council with recommendations. This report will supplement the one made to the Council in 1948.

W. K. Warren, Warren Petroleum Corporation, Tulsa, is chairman and the following are members: Fayette B. Dow, National Petroleum Association, Washington; C. F. Dowd, Tide Water Associated Oil Company, New York; J. W. Foley, The Texas Company, New York; J. H. Forrester, Stanolind Oil & Gas Company, Tulsa; B. C. Graves, Union Tank Car Company, Chicago; W. E. Huston, Republic Oil Refining Company, Pittsburgh; Arthur C. Kreutzer, Liquefied Petroleum Gas Assn., Inc., Chicago; John F. Lynch, LaGloria Corporation, Corpus Christi, Texas; Joseph Miller, Humble Oil & Refining Company, Houston; J. R. Parten, Woodley Petroleum Company, Houston; K. W. Rugh, Phillips Petroleum Company, Bartlesville, Oklahoma; A. R. Thomas, Shell Oil Company, Inc., New York; and J. W. Vaiden, Skelly Oil Company, Tulsa.

NEW FILTER PLANT—A new filter plant which cost three quarters of a million dollars was placed in operation last month at Freedom-Valvoline Oil Company at its Freedom, Pa., refinery. This addition will more than double the filtering capacity at the Freedom refinery and will permit greatly expanded production of waxes, petrolatums, and other specialties, in addition to increased output of the high grade oils, greases, and other petroleum products.

The new filtering equipment was designed by the Freedom-Valvoline engineering department and incorporates many new ideas not previously in use. Actual construction was begun last February under the supervision of Joseph L. Blount, general superintendent at the Freedom refinery and K. W. Nichols, superintendent of filtering processes. Nichols will supervise operations.

Other parts of the expansion program which have been completed include increased distillation and de-waxing capacity.

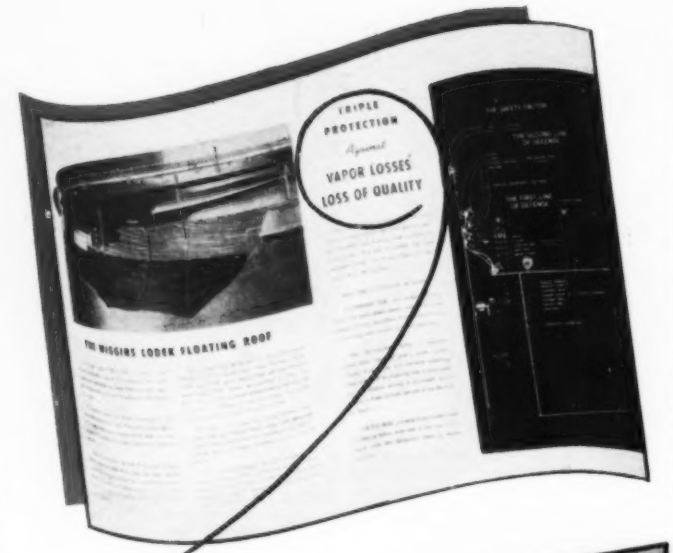
In the photo, starting oil through the percolation filters of the new filter house are shown left to right: Gus Doll, vice chairman of the board (kneeling); Earl M. Craig, president; B. L. Heath, vice president in charge of manufacturing; and C. L. Archer, vice president, secretary and treasurer.

Carnegie Names Rossini Chemistry Department Head

Dr. Frederick D. Rossini, chief of the thermochemistry and hydrocarbons section of the National Bureau of Standards, has been appointed professor and head of the chemistry department at Carnegie Institute of Technology. The appointment is effective July 1, 1950. Dr. Rossini succeeds Dr. J. C. Warner who is the school's new vice president and president-elect.

A graduate of Carnegie Institute of Technology, Rossini, two years ago, received the school's fifth honorary doctorate given in its 50-year history, in recognition of "his efficient use of the natural resources of the whole world and the adaptation of them to new uses for the benefit of mankind." He was the first alumnus to receive such an award from the institute. In 1934 he was the winner of the Hillebrand Award of the Chemical Society of Washington for his work on the thermochemistry of hydrocarbons.

He received his B. S. in chemical engineering in 1925 and M. S. degree in 1926 from CIT and taught school three



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years during his undergraduate and graduate days. He received his doctor of philosophy from the University of California, having served as a teaching fellow there.

Ashland-Aetna Merger Needs Stockholders OK

Plans for merger of Ashland Oil & Refining Company and Aetna Oil Company have been completed and will be submitted to stockholders of the two companies for approval. Walton T. Davis, president of Aetna Oil Company, said that the merger will put his company in the position of being able to supply increasing quantities of products. Ashland has a cat cracking capacity of 18,000 barrels per day and crude oil refining capacity of 40,000 barrels per day.

Besides the 8000-barrel-per-day refinery at Louisville, Ky., Aetna facilities include a terminal at Cincinnati and 14 river barges.

Refinery Managers Are Appointed by Union Oil

Kenneth E. Kingman has been appointed manager of manufacturing for Union Oil Company of California, Elmer B. Palmer succeeding him as manager of the company's Los Angeles refinery.

A graduate of the California Institute of Technology, Kingman joined Union in 1929 as a research chemist at the Los Angeles refinery. He has served in various capacities, including manager of the Wilmington refinery commencing in 1945.

Palmer joined Union immediately after his 1920 graduation in chemistry from U.S.C. Since early this year he has been assistant refinery manager.

Koppers Names Three Departmental Heads

Fred Denig, vice president, has been made production department manager of Koppers Company, Inc. with Dr. G. Frank D'Alelio succeeding him as vice president and manager of the research department. Dr. A. R. Powell assistant manager of the research department, has been made associate manager of that department.

Denig who joined the company in 1921 has been a vice president and manager of its research department since 1934.

D'Alelio joined the company in 1947 as an assistant manager of the research department. He is an authority on plastics, being the holder of 269 patents.

Dr. Powell came to Koppers Company, Inc., in 1923 after four years research on coal, gas and other fuels for the U. S. Bureau of Mines. He has also been in charge of research operations at the company's Kearny, N. J. and Chicago plants. In 1932 he became assistant manager of the research department.

LPGA Names Executives

Liquefied Petroleum Gas Association, Inc. has appointed R. H. Mahnke assistant managing director, Chicago headquarters, and K. B. Jacobsen West

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Coast secretary, Okland, Calif. headquarters.

With Kansas Electric Power Company from 1934 to 1942, Mahnke has been executive vice president of Kansas LP-Gas Association since 1946. He is a 1933 graduate of the University of Kansas. Jacobsen succeeds Don McNary, who resigned from the west coast post to go with Calor Gas Company, Oakland. A former department head for Key System Transportation Company in the Bay area, Jacobsen was more recently public relations officer of the Oakland naval supply center. He is a graduate of the University of California.

Ethyl Awards Fellowships To American Universities

Seven grants for graduate fellowships and one for post-doctorate research work have been granted by Ethyl Corporation to eight American educational institutions. The fellowships are sponsored in fields of interest to the petroleum, automotive and chemical industries, all of which the company serves. Carrying an aggregate value of $12,000, the awards for the 1949-1950 school year continue a program which the company began in 1937 for enabling promising graduate students to complete their education.

NPA's Fire Group to Hold 1950 Meeting in Cleveland

The twenty-fifth annual meeting of the National Petroleum Association's Department of Fire and Accident Prevention will be held in Cleveland in May, 1950. At October's semi-annual meeting at the Mt. Vernon, Ind., refinery of Indiana Farm Bureau Cooperative Association, the association voted to discontinue the fall semi-annual meetings.

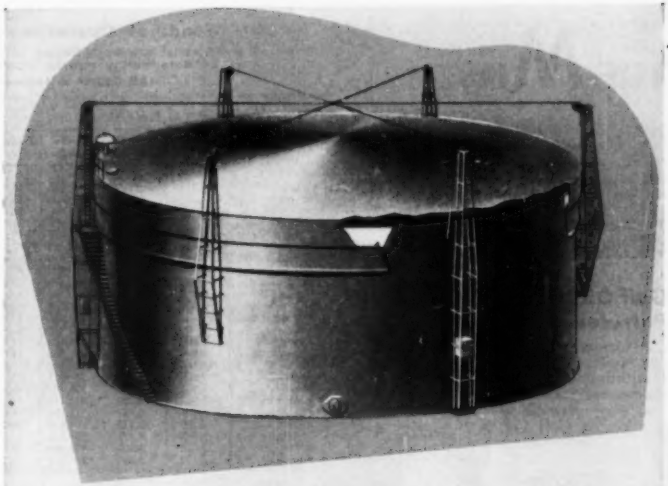
Stano Personnel Changes

C. L. Kelley, formerly assistant field superintendent of Stanolind Oil and Gas Company's Slaughter area at Brownfield, Texas, has been named field superintendent there to replace L. L. Bechtel, recently retired.

E. R. Wagner, who had been plant superintendent at Slaughter gasoline plant, is being transferred to the North Cowden gasoline plant at Odessa, Texas, as superintendent. He will head the new plant office which Stanolind has established to serve the North Cowden plant.

Ethyl Names Three for Technical Service Posts

Dan M. Guy has been appointed director of technical service in Ethyl Corporation's research laboratories at Detroit. He will also continue as head of the agricultural section of technical service, a post he has held for four years. Other transfers include M. A. Remondino, research engineer in the company's San Bernardino road test laboratory, to the commercial engine and fleet section of technical service operations in the re-



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THE MONTH . . .

search laboratories in Detroit, and of John D. Bailie, research engineer in the commercial engine and fleet section, to the agricultural section of technical service.

Guy joined the corporation at New York in 1931 as a field engineer in the sales department.

Gulf Oil Directors Elect Petroleum Economist

A former assistant curator of mineralogy and petrology at the Smithsonian Institution in Washington, Joseph E. Pogue, New York petroleum economist, has been elected a member of Gulf Oil Corporation's board of directors. Pogue, a vice president of the Chase National Bank, New York, will also serve the company in a consulting capacity.

Pogue

In 1913, Pogue joined the U. S. Geological Survey as associate geologist and later became associate professor of geology and mineralogy at Northwestern University. During World War I, he was assistant director, Bureau of Oil Conservation, U. S. Fuel Administration, following which he was associated with Sinclair Consolidated Oil Corporation as manager of the department of economic research. In 1920 he established his own consulting engineering firm.

He was formerly a member of an advisory committee on Economics to the Interstate Oil Compact Commission in 1938 and during World War II was made special assistant to the chairman and subsequently assistant to the chairman of the National Oil Policy Committee of the Petroleum Industry War Council.

Pogue is the author of several books on the economics of the petroleum industry and has contributed numerous articles to scientific and industrial publications.

Stanolind Announces Eight Plant Supervisory Changes

A number of transfers involving supervisory personnel at Stanolind Oil and Gas Company plants have been announced by John R. Evans, manager of the company's North-New Mexico division. Harold S. Jones, who was superintendent of the South Jennings recycling plant near Jennings, La. has assumed duties of plant superintendent at the Slaughter gasoline plant, Sundown, Texas. Jack E. Fulgham, who has been plant engineer at Slaughter, has been named plant foreman there. Kenneth L. Redman, formerly a mechanical engineer at the South Jennings plant, has been transferred to Slaughter where he will be plant engineer.

Glen A. Ayling, plant foreman at the Slaughter gasoline plant, went to Levelland, Texas, to become plant foreman at the gasoline plant, as did R. N. Hall, plant engineer, who was process engineer in the Tulsa general office, and Norris H. Trostel, operating engineer who was formerly a mechanical engineer at the Luby gasoline plant near Bishop, Texas.

The South Fullerton gasoline plant near Andrews, Texas, has also received Lloyd E. Childers, formerly operating engineer at the Stano gasoline plant, Ulysses, Kansas, and Arthur H. Denny, previously a member of the manufacturing department, Tulsa general office. Childers will become operating engineer at South Fullerton and Denny plant engineer.

Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

Trends in Week Ended	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1948:									
January 31	5,318	5,434	228,083	15,986	102,973	7,690	37,733	9,141	35,510
February 28	5,387	5,463	226,860	15,796	111,040	7,963	30,689	8,824	34,742
March 27	5,377	5,324	229,409	15,783	112,991	7,682	27,483	8,854	33,483
April 24	5,415	5,517	228,488	16,515	111,128	6,831	30,808	8,877	34,437
May 29	5,452	5,715	228,979	17,827	107,185	7,054	34,862	9,508	39,969
June 26	5,494	5,674	229,632	17,938	104,178	7,200	41,137	8,858	42,558
July 31	5,455	5,718	230,720	17,646	99,116	6,823	52,429	9,080	48,618
August 28	5,529	5,682	229,873	17,722	95,504	7,491	61,814	8,818	53,544
September 25	5,343	5,285	234,193	16,705	90,410	6,656	71,428	6,380	57,745
October 30	5,604	5,626	239,702	17,569	91,925	7,679	77,118	8,853	60,845
November 27	5,617	5,721	244,246	17,317	89,802	7,476	80,375	9,477	63,960
December 33	5,641	5,784	250,555	18,178	100,286	7,776	74,576	9,121	63,374
1949:									
January 29	5,493	5,490	255,459	17,531	114,677	7,547	63,142	8,178	63,333
February 26	5,401	5,412	261,965	17,621	124,382	7,430	54,008	8,225	59,348
March 26	5,188	5,353	266,506	17,417	128,087	6,167	48,721	8,305	58,792
April 30	4,980	5,273	271,255	17,969	124,787	6,681	49,959	8,185	60,174
May 28	4,951	5,297	275,190	18,324	120,661	5,943	55,971	8,144	63,758
June 25	4,944	5,322	274,114	18,462	115,715	5,148	63,049	7,856	66,146
July 30	4,731	5,187	271,999	18,058	109,964	6,293	70,767	7,205	67,166
August 27	4,769	5,215	264,458	18,180	106,280	6,491	74,718	7,597	68,394
September 24	4,933	5,377	259,189	18,152	103,262	6,555	81,414	7,419	68,143
October 29	5,075	5,509	252,069	19,002	103,915	7,016	90,358	7,754	69,459
November 26	5,192	5,331	*256,374	18,204	104,917	6,971	91,795	8,104	67,087

* November 19, Stocks.

THE OIL MAN'S CALENDAR

1950 JAN. 9–13	Society of Automotive Engineers, Detroit, Hotel Book-Cadillac.
FEB. 9–10	Southern Gas Association, Meter and Regulator Conference, Houston.
27 to Mar. 2	American Society for Testing Materials, Pittsburgh, William Penn Hotel.
MAR. 27–29	Western Petroleum Refiners Association, 38th Annual Meeting, San Antonio, Plaza Hotel.
APRIL 3– 5	Society of Automotive Engineers, Aeronautic and Air Transport, New York, Hotel New Yorker.
5– 7	Illinois Institute of Technology, Midwest Power Conference, Chicago, Sherman Hotel.
10–14	American Society of Mechanical Engineers, Washington, D. C., Hotel Statler.
11–13	Southwestern Gas Measurement, Short Course, Norman, Okla., University of Oklahoma.
12–14	National Petroleum Association, Cleveland, Ohio, Hotel Cleveland.
24–25	Industrial Accident Prevention Association, Toronto, Canada, Royal York Hotel.
24–26	Natural Gasoline Association of America, Annual Convention, Fort Worth, Texas, Texas Hotel.
24–26	American Society of Mechanical Engineers, Process Industries, Pittsburgh, William Penn Hotel.
MAY 1– 4	American Petroleum Institute, Division of Refining, Mid-Year Meeting, Cleveland, Ohio, Hotel Cleveland.

Gulf Oil Names Regional Public Relations Men

The public relations department of Gulf Oil Corporation has been expanded with the appointment of three regional

Drew

Halliwell

public relations men. Representing the company in the Pittsburgh general office and in the Midwest area, is John M. Halliwell. Warren M. Drew, located in New York, will direct activities in the East, and Don Riddle, headquarters in Houston, will represent the Southwest.

Riddle

Prior to his recent appointment, Halliwell was an administrative assistant to the advertising manager. He joined the company following his graduation from the school of business administration, University of Pittsburgh in 1935. As a member of the advertising and sales promotion department since that time, he has been engaged in company magazine editing, dealer training, and publication and radio advertising.

Drew, an alumnus of the University of Illinois, joined Gulf Oil Corporation shortly after his return from World War II. Before entering the service, he was associated with the Millis Advertising Agency and McGraw-Hill Company in New York. For six years he

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Taylor Spiral-Weld Pipe is again promptly available in a broad range of sizes and thicknesses. Coupon brings new Spiral Pipe Bulletin 493.

1 Seamless throughout

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THE MONTH...

was an independent public relations counsel.

Riddle, came to Gulf Oil Corporation in 1933 with an advertising agency, public relations, and newspaper background. He is a graduate of Simmons College, Abilene, Texas. Prior to his present assignment he was associated with the company's advertising activities in the Houston division sales office.

Refinery Projects Assure 82 Percent of OEEC Goal

Refinery projects actually under construction or on which work soon will be started, regardless of source of financing, already assure western Europe of achieving by mid-1953 a crude thruput capacity of about 1.12 million barrels per day. This is nearly 82 percent of the expansion goal of 1.24 million barrels per day set out in the program approved by the Organization for European Economic Co-operation. Also it is only 40 million barrels per day short of total of 1.06 million barrels per day ECA is reported now to regard as representing top limit of a program it can reasonably go along with.

At present time, ECA is said to be actively considering project which would give Europe an additional 40,000 barrels per day capacity and which, if approved for financing, would bring Europe up to ECA's arbitrary 53-million-ton ceiling.

Dr. O. E. Bransky, acting chief of ECA petroleum branch, said he believed the program eventually would be fixed at a little more than 1.01 million barrels, but under the OEEC goal of 1.24 million barrels by 1953. He said that Marshall Plan nations' estimate of increased consumption at rate of 9 percent yearly in their countries was too high. This estimate, he added, formed the basis for OEEC's goal of 1.24 million barrels.

Bransky said that the ideal solution to problems of expansion and currency restrictions "would be a return to normal trading conditions but the continuing dollar shortage will probably prevent this."

ECA Studies Refinery Program for Europe

A breakdown, by countries, of the refinery program for Europe, approved in principle by the Office of European Economic Co-operation and under study in Washington by ECA, is shown below. All figures are in units of 1000 metric tons and are stated in terms of crude oil.

Austria, thruput, 620, refinery output, 519; Belgium, Netherlands and Luxembourgh thruput, 8258, output, 7399; Denmark, 30 and 27.5; France 18,775, and 17,135; Greece, 400, and 358.

Iceland, none; Ireland, none; Italy (incl. Trieste), 8,115, and 7,329; Norway, 370, and 31.3; Portugal, 370, and 341; Sweden, 1540, and 1379; Switzerland, 100, and 90. Turkey, 61, and 55.5; United Kingdom, 19,351, and 17,306; Trizone, 4720, and 4200.9.

Total thruput, 62,375, total output, 56,189.2.

Markham Named Acting API Head, Jones Chairman at Annual Meeting

Baird H. Markham, director of the American Petroleum Industries Committee, was named acting president of the American Petroleum Institute at the 29th annual meeting of the organization in Chicago, November 7-10. Markham succeeds William R. Boyd, Jr., president of API since 1941. He will serve as acting president until March, 1950, when the board of directors will meet to consider election of a permanent president. Boyd some months ago announced his intention to retire.

The API board of directors during the meeting, which was attended by more than 5000 oil industry personnel, created the post of chairman of the board of directors to which it elected W. Alton Jones, of New York, president of Cities Service Company. Boyd had previously performed the duties of president and chairman.

J. Howard Pew, director and former president of Sun Oil Company, was awarded the API "Gold Medal for Distinguished Achievement," at a general session of the convention. The citation presented with the medal called Pew "a courageous leader" of the oil industry for a period of almost 50 years, and a "vigorous champion of competitive enterprise." In his acceptance Pew said that advocates of high taxes and higher wages are supporting their claims with totally unrealistic estimates of postwar corporate profits. He charged that stories of legendary corporate profits are poisoning the minds of the people, and urged that they be given the unvarnished truth that such profits do not exist.

Rewards of Research

Dr. Robert E. Wilson, chairman of the board of Standard Oil Company (Indiana), Chicago, who spoke during the general session pointed out that both the public and the industry have benefited greatly from the API-sponsored basic research program, particularly in production of 100-octane gasoline, conservation of distillate from natural gas, advanced production practies, design of refinery equipment, laboratory methods, and standard samples of pure hydrocarbons.

The future should hold rich opportunities and possibilities for all Americans and for the petroleum industry, according to Robert S. Kerr, U. S. Senator of Oklahoma, in his address at a second general session. He expressed great confidence in the future of America and the petroleum industry, and urged diligence in the matter of relations with the public and the government. The unchallenged reality of American abundance, he said, in advocating free enterprise, is enough to slay the enemies of free enterprise.

Edmund P. Learned, professor of business administration, Harvard Graduate School of Business Administration, in his address, "Integration in American Industry" said that the integration in the petroleum industry tended to afford economies which benefit the consuming public. It is hardly to the public interest to discourage the development of efficient and lower cost methods, he said.

Markham

Jones

Admiral Louis E. Denfeld, chief of naval operations and a member of the Joint Chiefs of Staff, told the convention that the Navy has always been a firm believer in the fact that the surest guarantee of ample petroleum products in peace or war is a healthy, vigorous, and progressive petroleum industry, and that the Navy keeps in close touch with the industry and is realistically solicitous of its best interests. If the Navy is not the best single customer of the industry, he said, it is the most appreciative.

Vice President Alben W. Barkley told the session of the Division of Marketing, that he believed it is to the interest of the country not to give the tidelands reserves that belong to all the people back to the individual states. The oil reserves beneath the Continental Shelves should be retained by the federal government for the protection of "the economy of the United States and the defence of the United States," he said.

Public Relations

George W. Freyermuth, manager of the public relations department of the Standard Oil Company (New Jersey), New York, was elected 1950 chairman of the Oil Industry Information Committee, to succeed Conger Reynolds, Standard Oil Company (Indiana). Three vice chairmen were elected: Phillip Humphrey, The Texas Company, New York; Stanton Smith, Smith Oil & Refining Company, Rockford, Ill.; and William Gerwe, Socony-Vacuum Oil Company, Inc., Chicago.

The board of directors of the institute approved continuance of the public relations program in 1950 on a slightly enlarged basis. The new budged was upped $119,200 over 1949 to a total of $1,811,000. They authorized a consolidation of the work, a step that had been planned from the start of the program. Under this plan, functions handled by Fred Eldean Organization, Inc., are transferred to an extended department of information within the API. The membership of the Oil Industry Information Committee, which will continue to function as an advisory program-planning group, generally responsible for the over-all program, will be expanded to include the chairmen of the district committees, which will raise membership from 24 to 35.

The group session for the Division of

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THE MONTH . . .

Refining, with Chester F. Smith, Standard Oil Company (New Jersey) presiding, heard William M. Holaday, Socony-Vacuum Oil Company, Inc., New York, discuss "Fuels—Their Present and Future Utilization." The presentation by Holaday, R. E. Albright, T. L. Apjohn, and L. R. Steffens points out that less than one third of the energy consumed in this country is used effectively. If a petroleum shortage should occur in the future, the use of liquid fuels could be curtailed in fields where other fuels can be used with little or no loss in efficiency, and the liquid fuels conserved for applications where no suitable substitute is likely to become available, he said.

Industry and government must plan together if the United States is to be assured of a sufficient supply of oil to defend itself in case of attack, Walter G. Whitman, Massachusetts Institute of Technology, told the division in an address, "Liquid-Fuel Supplies and National Security." (This article appeared in the November, 1949, PE.)

The oil market in this country has had things happening to it during the past 15 or 20 years to make it a lot more seasonal, and widespread swings in the normal level of demands at different times of the year have given rise to a whole new set of operating problems, Courtney C. Brown, Standard Oil Company (New Jersey), said in his address "Effects on Refinery Operations of Increase in Seasonals in Petroleum Product Demands." One of the problems, he said, is the requirement for more storage capacity and the practice of using it.

The API 1950 annual convention will be held in Los Angeles, November 13-16, as scheduled previously by the executive committee; however, the convention will return to Chicago for the 1951 meeting November 5-8.

Commenting on the gasoline market, Brown said the evening-out of the market has contributed to the reversal between the levels of winter and summer demands, but the most dominant influence has been the increase in the light burning oil market, the middle fractions consisting of kerosine and distillates. While these fractions are used for a number of purposes, the greatest volumes are used for heating, which is a highly seasonal market that varies sharply with the weather. Brown discussed demand and supply trends for winter and summer periods for gasoline, middle distillates, and others.

There are three ways for the industry to adjust itself to the increased seasonals, he said. The first way would consist of having a total supply capacity sufficiently higher than the average annual requirements, then activity could be expanded during the period of seasonal peak. A second way would be to shift refinery yields, and the third method is by adding to inventories in the slack season, the stocks that would be delivered in the peak season. Each method has limitations, although they have been used with some degree of success in combination. In his opinion, the refiners could make large capital savings if they should gradually adopt the operating practice of letting the changing seasonal requirements fall more on storage and less on changing volumes of currently produced supplies.

The present practice of adjusting current supplies to meet seasonal demands, cannot help but result in shut-in crude, idle refinery and pipeline capacity, and tied-up tankers for a part of each year, which is idle capacity of the most expensive kind, he said.

Committee Selections

Paul G. Blazer, board chairman of Ashland Oil and Refining Company, Ashland, Ky.; Reid Brazell, board chairman of Leonard Refineries, Inc., Alma, Mich.; M. H. Robineau, president, Frontier Refining Corporation, Cheyenne, Wyo.; E. L. Shea, president, Ethyl Corporation, New York, and W. S. Zehrung, president, National Petroleum Association, were appointed members of the general committee of the division of refining for 1950.

The other 45 members of the general committee of the division of refining were elected in open session of the division. They are as follows:

W. R. Argyle, Sinclair Refining Company; M. W. Boyer, Esso Standard Oil Company; G. H. Burrus, Anderson Prichard Oil Corporation; H. S. Chase, Tide Water Associated Oil Company; W. J. Carthaus, Deep Rock Oil Corporation; G. A. Davidson, Standard Oil Company of California; C. E. Davis, Shell Oil Company, Inc.; D. E. Day, Richfield Oil Corporation; John C. Day, Western Petroleum Refiners Association; Roy J. Diwoky, Pan-American Southern Corporation; J. H. Dunn, Shamrock Oil & Gas Company, and E. E. Ebner, Quaker State Oil Refining Corporation.

H. W. Ferguson, Humble Oil & Refining Company; Max M. Fisher, Aurora Gasoline Company; A. P. Frame, Petroleum Advisers, Inc.; M. Halpern, The Texas Company; John Hancock, Hancock Oil Company; Basil Hopper, Union Oil Company; H. Y. Hyde, Tidewater Associated Oil Company; W. Y. Keeler, Phillips Petroleum Company, and J. A. La Fortune, Warren Petroleum Corporation.

J. Porter Langfitt, The Pure Oil Company; H. A. Logan, Elk Refining Company; W. F. Lowe, National Gasoline Association of America; R. E. Luton, Ohio Oil Company; P. S. Magruder, General Petroleum Corporation; Maurice Machris, Wilshire Oil Company; E. B. McConnell, The Standard Oil Co. (Ohio); Frank W. McCurry, Derby Oil Company, and L. W. Moore, Pan-American Petroleum & Transport Company.

John W. Newton, Magnolia Petroleum Company; J. L. Nolan, Farmers Union Central Exchange; Harold G. Osborn, Continental Oil Company; Max G. Paulus, Standard Oil Co. (Indiana); J. B. Rogerson, Lion Oil Company; W. F. Stroud, Atlantic Refining Company; T. J. Sullivan, Gulf Oil Corporation; C. S. Tedsworth, Socony-Vacuum Oil Company, Inc.; C. H. Thayer, Sun Oil Company,; R. L. Tollett, Cosden Petroleum Corporation; J. W. Valdeh, Skelly Oil Company; John S. Wertz, Vickers Petroleum Company; C. R. Williams, Chicago Corporation; L. E. Winkler, Rock Island Refining Corporation, and G. E. Wynn, Mid-Continent Petroleum Corporation.

Those elected to the refining group of the API Board of Councillors include:

Pacific Coast: P. E. Lakin, Shell Oil Company, Inc., and W. L. Stewart, Jr., Union Oil Company of California.

Central U. S.: R. B. Anderson, Waggoner Estate; C. M. Boggs, The Kanotex Refining Company, and Reid Brazell, Leonard Refineries, Inc.

Eastern U. S.: Paul G. Blazer, Ashland Oil & Refining Company; Harry A. Logan, United Refining Company, and Charles L. Suhr, The Pennzoil Company.

Everett Process Engineer With Houdry Corporation

Edward F. Everett, Jr., has been added to the engineering department of Houdry Process Corporation as senior process engineer. He comes to Houdry Corporation from Marshall - Morman Development Company, New York, where he was engaged for several years as a process engineer. Before that he was, for ten years, a process engineer with The M. W. Kellogg Company.

Everett

His work has been in the development of hydroforming, both for war and peace-time application in the petroleum industry, and he also had an active part in the wartime butadiene program for the manufacture of synthetic rubber.

Everett's bachelor's degree in chemical engineering practice is from the Massachusetts Institute of Technology as well as his master's degree, which is in chemistry.

Oil Men Honor Boyd

Nearly 200 oil men, including members of the API board of directors and close personal friends, paid tribute to William Rufus Boyd Jr. at a testimonial dinner in Chicago last month on the occasion of his retirement as API president.

W. Alton Jones, president of Cities Service Company, was master of ceremonies and presented Boyd with a silver service, a gift of the board. Later, a scroll on parchment, bound in leather was presented him with the signatures of 126 of the institute's directors.

Cities Service Completing New Cicero Compound Plant

Construction on Cities Service Oil Company's $4 million compound plant at Cicero, Ill., is about half complete with first blending operations there scheduled for the middle of 1950.

Located on a 42-acre tract on the Illinois Ship Canal near the edge of Chicago, the plant is designed to compound and blend more than 23 million gallons of lube oils per year. Supplemental facilities include a dock on the ship canal for receiving blending stocks, a laboratory, office, garage, boiler plant, storage tanks and a loading dock for both rail and transport facilities.

Blending stocks will be obtained from a solvent-refined lube oil plant, newly completed at Lake Charles, La., and barged up the Mississippi and Illinois rivers to the Cicero plant.

MFA Completes Desulfo Unit

MFA Oil Company has completed construction at its Chanute, Kans., refinery of a Perco Cycloversion unit for desulfurization engineered by Koch Engineering Company, Wichita, Kans. The single catalyst chamber unit costing $75,000, has a design capacity of 1000 barrels per stream day.

Plymouth Plant Operating

The first gas from Plymouth Oil Company's new $7 million natural gas plant in the Benedum field, Texas, has been turned into the El Paso Natural Gas Company's pipe line, which carries the gas to the Pacific coast.

After first tests, the gas flowed through the line at the rate of about four million cubic feet per day, according to Walter S.

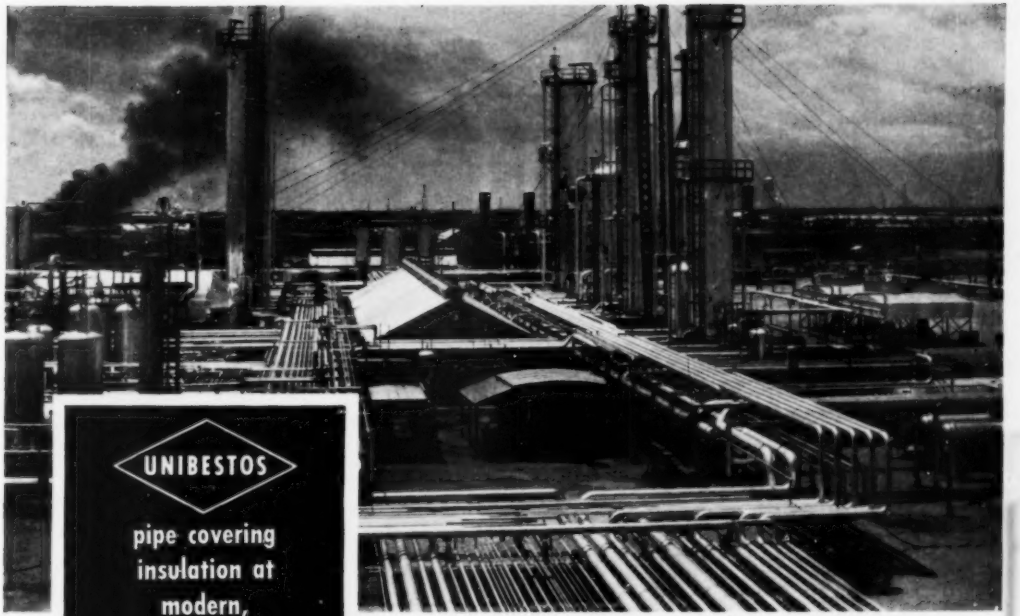

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Photo: courtesy of Sid Richardson Company, Texas.
Insulation Contractor, The Aber Company, Shreveport, La. and Houston, Texas.

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S-98

Hallahan, president. The contract with the El Paso Natural Gas Company contemplates the delivery of 60 million cubic feet daily.

Stanolind's Gasoline Plant Starts First Operations

The first phase of operations at Stanolind Oil and Gas Company's gasoline plant, near Levelland, Texas, began early last month. The entire Levelland field gathering system was cut in and the casinghead gas is being compressed, sweetened and dehydrated at the plant. The residue gas is sold to a gas pipe line company, while the unstabilized condensate is being shipped to the Slaughter gasoline plant, 15 miles away, to be re-run and stabilized.

Final completion of the absorption, distillation and fractionation sections at Levelland is scheduled for February 1, 1950. When completed, it will have a daily capacity of 40 million cubic feet of gas and a maximum liquid product output of more than 130,000 gallons daily.

Mitt Dowlen is superintendent.

Modernized Gaso Plant Opened by Cities Service

Cities Service Oil Company (Delaware) has completed modernization and expansion of its natural gasoline plant at Pampa, Texas, and the new facilities are now in operation. The program included replacement of all distillation equipment, the installation of fractionators to separate the products, the replacement of cooling tower, boiler plant, all water treating equipment and pumping units. The compression plant and direct-fired oil heaters were about the only units retained. Two stages of compression were added with the installation of four 600 hp. angle-type gas engine driven compressors, increasing total hp. of the plant to 4,200.

The plant has been designed to eventually process 18,000 mcf. of gas daily.

British American Chooses Edmonton Refinery Site

As the latest addition to British American Oil Company's expanding Alberta, Can., holdings, the Edmonton area has been chosen for the site of a new oil refinery, which, when completed, will have an initial capacity of 2 million barrels yearly. Tenders have been requested and contract for construction will be awarded on a competitive basis, although actual construction of the refinery will not be started until early next spring, with completion scheduled for a year and a half later.

Surveys are being conducted on 500 acres of land in Townships 52 and 53, Range 23, four miles east of Edmonton. From these, 160 acres will be selected to accommodate the refinery and enable warranted expansion, officials declared.

The plant, which will depend entirely upon local crude for supply, will raise the company's total refining capacity to 60,500 barrels per day.

THE MONTH...

Above—Night view of Cit-Con Oil Corporation's new lubricating oil refinery at Lake Charles, La. At right—Entrance to Cit-Con's administration building which houses executive and clerical personnel.

THE world's "most modern solvent refined lubricating oil refinery" was to have been dedicated on December 8, 1949, at Lake Charles, La.

It is a $42,000,000 plant, built and operated by the Cit-Con Oil Corporation, which is a joint enterprise of Cities Service Company, which owns 65 percent, and the Continental Oil Company which owns 35 per cent.

The new refinery was designed and built to produce superior quality motor oils to meet the greater strains placed on lubricants by the higher operating temperatures and greater bearing loads of today's engines.

The plant spreads over a 367-acre tract, 12 miles southwest of Lake Charles. Two of its processing units are the largest of their type ever built. These are the furfural and the Duo-Sol solvent refining units.

Cit-Con's design production capacity is 6000 barrels of lubricating oil base stock daily, or 2,100,000 barrels a year, plus an annual output of 70,000,000 pounds of fully refined paraffin wax of the quality used by the food packaging industry.

In the new method of refining utilized by Cit-Con the lubricating fraction of crude oil is subjected, under carefully controlled conditions, to solvents which remove selectively all the naturally occurring unstable compounds.

The product resulting from this method is "as stable a base for the manufacture of lubricating oil as modern refining technique can produce."

The five base stocks produced by the refinery may be blended into hundreds of combinations to meet specific requirements for automotive and industrial lubricating oils.

Officers of Cit-Con are W. Alton Jones, chairman of the board; Burl S. Watson, president of the Cities Service Refining Corporation, president; A. P. Frame, president of the Cities Service Research and Development Company, vice president; Harold G. Osborn, vice president of the Continental Oil Company, vice president; F. M. Simpson, vice president and general manager; B. R. Johnstone, secretary; C. E. Weger, treasurer; E. E. McWhiney, assistant secretary and assistant treasurer; B. M. Scofield, assistant secretary, and L. M. Coleman, assistant treasurer.

Further description of the plant is contained in an article which appears on pages 150-151 of this issue of PR.

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Fig. 6061—Class 600-pound Cast Steel Swing Check Valve.

There are obvious disadvantages in buying flow control equipment from several different sources. Then why get your bronze or iron valves from one place, your steel valves from another, and possibly corrosion-resisting valves from several others, when Powell *makes them all**?

This is an age of specialization; and whereas various manufacturers are emphasizing valves that meet certain flow control requirements, Powell specializes in making valves to meet *all* the demands of every branch of Industry. And there's only one standard of quality at Powell—to make the right valve to suit the service, and to make it the best.

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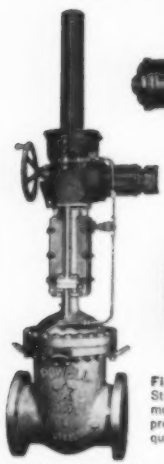

Fig. 3023—Class 300-pound Cast Alloy Steel Gate Valve with automatic steam sealing mechanism. Has explosion proof electric motor operator.

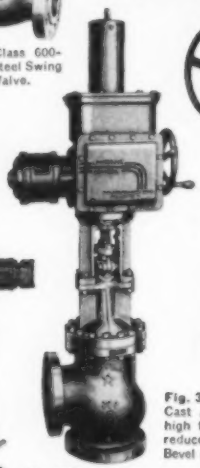

Fig. 3053 — Class 300-pound Cast Steel Angle Valve, equipped with top-mounted, fully enclosed, explosion-proof, electric motor operator for quick, positive opening and closing.

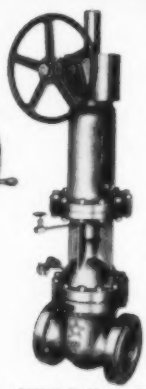

Fig. 3003 S. S. Mod.—Class 300-pound Cast Alloy Steel Gate Valve for ultra-high temperatures. Has cooling fins to reduce temperature in the stuffing box. Bevel gear operated.

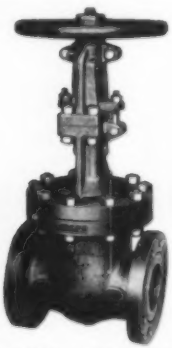

Fig. 3003—Class 300-pound Cast Steel O. S. & Y. Gate Valve.

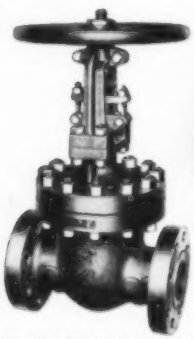

Fig. 9003—Class 900-pound Cast Steel O.S.& Y. Gate Valve.

Fig. 1793—Large 125-pound Iron Body Bronze Mounted O.S.& Y. Gate Valve.

Fig. 241—Large 125-pound Iron Body Bronze Mounted O. S. & Y. Globe Valve.

Fig. 8150—Bronze L. P. G. Globe Valve with screwed ends, union bonnet and special composition disc.

Fig. 1708 — 200-pound Bronze Globe Valve with renewable stainless steel seat and regrindable, renewable "Powellium" nickel-bronze disc.

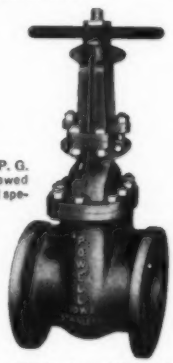

Fig. 2453-G—Large 150-pound Stainless Steel O. S. & Y. Gate Valve. Sizes 5" to 30".

* Powell Valves are made in Bronze, Iron, Steel and a wide selection of Corrosion-Resistant metals and alloys. Valves of every type—Globe, Angle, Gate, Check, Non-return and Flush Bottom Tank Valves—are included in the Complete Powell Line.

Fig. 1314-A — Class 1500-pound Steel Integral Bonnet "Y" Valve. Also made in Globe and Angle patterns.

Fig. 375 — 200 - pound Bronze Gate Valve with renewable "Powellium" nickel-bronze disc.

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SCIENCE and TECHNOLOGY Abstracts

Prepared by
DR. E. H. LESLIE and DR. H. B. COATS
The Leslie Laboratories
Traver Road, Ann Arbor, Mich.

Manufacture: Processes and Plant

Technique of Performance Studies on Commercial Fractionators. EDWARD GELUS, STANLEY MARPLE, JR., AND EARL MANNING, JR. *Chem. Eng. Progress*, **45** (1949) pp. 602-8.

The authors describe the techniques used in several evaluations of fractionating columns that were integral parts of an operating unit and could not be released from service for purposes of testing. Obtaining of the test data is described and method of analysis of the data is given. Stream flow distribution, material balance, choice of equilibrium data, fractionation and loading calculations, and critical examination of the results are described. The procedure used is illustrated by an example based on a column preparing dimethylcyclopentane as the overhead fraction from a petroleum naphtha, and the over-all tray efficiency of the column was found to be 35 percent. Data are presented in some detail in tabular and graphical form, and a bibliography of 12 references is included.

Separation of Gas-Oil and Wax Fractions of Petroleum by Adsorption. BEVERIDGE J. MAIR, ALBERT J. SWEETMAN AND FREDERICK D. ROSSINI. *Ind. Eng. Chem.*, **41** (1949) pp. 2224-30.

Previously published reports from the Bureau of Standards have given the results of the separation of the gasoline and kerosine fractions of petroleum by adsorption. The present paper extends the ground previously covered, to gas-oil and wax fractions. The adsorbent used was silica gel. In a single-pass operation, the gas-oil fraction of petroleum can be separated into three portions—one that is a mixture of paraffins and cycloparaffins, a second that is largely mononuclear aromatics, and a third that is largely polynuclear aromatics. In a similar manner, the wax fraction containing some oily components, but free from aromatics, can be separated into two portions—one that is largely paraffins and a second that is largely cycloparaffins. Data are given on the effect in separating gas-oil from changes in several of the factors affecting the separation. A simple analogy between fractionation by adsorption and fractionation by distillation is drawn. Results are presented in considerable detail in tabular and graphical form and a bibliography of 13 references is included.

Phase Behavior of a Propane-Topped Crude Oil System. Application to Solvent Extraction Calculation. F. H. POETTMANN AND M. R. DEAN. *Chem. Eng. Progress*, **45** (1949) pp. 636-43.

The use of propane as a solvent in the refining of oils to effect the removal of asphalt, wax and other impurities is well established. However no design method has been reported that is directly applicable to complex systems such as propane-oil systems and which can be used as a basis to evaluate both pilot-plant and plant operation. The authors present a graphical design procedure for performing extraction calculations on complex mixtures. The method is similar to that described by Maloney and Schubert for solvent extraction of simple binary mixtures. The phase behavior of a propane-topped crude oil system is given and a typical calculation using the graphical procedure on this system is presented.

Economics of Thermal Reforming. C. F. FEUCHTER. *Chem. Eng. Progress*, **45** (1949) pp. 644.

The purpose of the paper is to show the manner in which the most economical combination of thermal reforming and the addition of tetraethyl lead can be determined, and to illustrate the effects of product prices, tetraethyl lead costs, and octane number specification on the economics of thermal reforming. The economics of thermal reforming will vary for individual refiners, depending on the type of crude oils processed and the type of equipment employed. Under the conditions assumed for the problems studied, and under present-day price conditions, maximum profits by thermal reforming are obtained when charging 3000 barrels per day of heavy naphtha, equivalent to a 275 to 400° F. boiling range charge, and when operating at a reforming severity equivalent to an octane number increase of about 14.0. The octane number specification of the finished product has a relatively large effect on the economics of thermal reforming. For high octane blends, it is necessary to reform thermally in order not to exceed the maximum allowable tetraethyl lead content of 3.00 cc. per gallon. A decrease in gasoline price increases the attractiveness of thermal reforming. At a low gasoline price it is possible to operate over a relatively wide range of reforming severities and still be near the optimum condition, whereas at high gasoline price, a small variation in reforming severity results in a large change in profits. Reforming is considerably more attractive when the price of butane is high than when it is low, and hence thermal reforming is more economically advantageous in the winter months than in summer.

These abstracts from the current literature of science and technology (not including trade journals easily available) were prepared by Drs. Leslie and Coats of The Leslie Laboratories, Traver Road, Ann Arbor, Mich., which will supply, at cost, photostatic copies of original articles. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, also may be had by arrangement with the laboratories.

Chemical Engineering Materials of Construction Review Editorial Symposium. *Ind. Eng. Chem.*, **41** (1949) pp. 2091-2153.

This is the 3rd annual chemical engineering materials of construction review. One new section on Less Common Metals has been added. The subjects lead and its alloys, and tin and its alloys are given separate treatment. Other subjects covered in this and in previous reviews are aluminum alloys, carbon and graphite, cement, ceramics, wrought copper and copper-base alloys, elastomers, fibers, iron, mild steels, and low alloy steels, nickel and high-nickel alloys, plastics, hard rubber, stainless steels and other ferrous alloys, and wood.

Products: Properties, Utilization and Analysis

Fuels for High Compression Engines. A Preliminary Study of the Selective Blending of Gasoline Distillates from Present-Day Refining Processes. W. C. OFFUTT, J. E. TAYLOR AND G. B. SWARTZ, JR. *Ind. Eng. Chem.*, **41** (1949) pp. 2359-65.

The authors express the opinion that the automotive and petroleum industries should develop engines and fuels simultaneously in order that the engines and the fuels will be properly matched. Any upgrading of fuel antiknock quality requirements of automotive engines should be established in advance of engine production in order to give refiners an opportunity to develop the techniques required to economically produce satisfactory fuels. Engines with compression ratios as high as 12.5 have recently been built. Such engines will begin to be used as soon as the techniques are developed to produce the fuel of high enough octane number to permit the satisfactory operation of such engines. Data presented in the paper summarize the road antiknock

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performance of several selectively blended gasoline distillates from presently operating refinery processes in specially designed engines of 8-to-1, 10-to-1, and 12.5-to-1 compression ratio. The hydrocarbon-type of the composition is shown to affect the road performance of the motor fuels, and a complete hydrocarbon analysis is therefore given for the fuels that were rated. The authors conclude that the fuel development program should be carried out in engines of the specific design expected to be used on the road, since antiknock ratings in stepped up, conventional experimental engines do not appear to be comparable. The road octane number of the motor fuels tested to date appears to increase with increasing compression ratio. Data are presented in detail in tabular and graphical form, and a bibliography of six references is included.

Components of Gasoline Produced by Catalytic Cracking. Augustus R. Glasgow, Jr., Charles B. Willingham and Frederick D. Rossini. *Ind. Eng. Chem.*, **41** (1949) pp. 2292-97.

The work was done to determine the hydrocarbon components in certain aviation fuel components. The paper presents the results of the analysis with respect to individual hydrocarbons of a gasoline produced by the catalytic cracking process of the fixed-bed type of Houdry design. Gas-oil or heavier distillate is cracked in the presence of a fixed bed catalyst, with the gasoline fraction from the first operation recycled through a similar operation. The analytical work was done by utilizing processes of distillation and absorption. Results are presented in detail in tabular and graphical form and a bibliography of 17 references is included.

The Viscosity of Aero-Engine Oils at Low Temperatures. S. G. Daniel. *Jour. Inst. of Petroleum*, **35** (1949) pp. 516-62.

The paper gives an account of the methods used and the results obtained while examining the viscous behavior of aircraft oils at low temperatures. Construction and operation of a viscometer is described, the purpose of which is to measure the viscosity of high-duty aircraft lubricating oils at shearing stresses up to 45,000 dynes per square centimeter and at temperatures of 20 to —25° C. Results that were obtained indicate the anomalous viscosity effects that can be expected at low temperatures and show that they are caused by the deposition of wax or other solid hydrocarbons from the oil. The magnitude of these effects is related to the crystal size of the solid hydrocarbons and to the amount present. However, the relationship is complex and further work of fundamental nature is necessary before a quantitative relationship can be expressed. The influence of a pour-point depressant upon the low-temperature flow properties of an oil is described, as well as the bearing of these results upon cold-starting of aero-engines.

Oil-Soluble Sodium Naphthasulphonates. Some Observations on Their Chemical Nature. V. W. David. *Jour. Inst. of Petroleum*, **35** (1949) pp. 563-73.

Sodium naphthasulphonates, which are useless as emulsifiers, and technical white oil sulphonates, which are good emulsifiers, comprise the same group of sulphonates based on the character of their

calcium, barium, lead, aluminum, and iron derivaties. However, it has been found that the two types of product can be readily distinguished by studying their behavior on extracting an alkaline aqueous solution of their sodium salts with petroleum ether. Two fractions are obtained, one soluble in alkaline aqueous alcohol, and the other soluble in petroleum ether. The former is a useful emulsifier. The latter is devoid of emulsifying properties.

Laboratory Low Temperature Fractional Distillation. C. E. Starr, Jr., J. S. Anderson and V. M. Davidson. *Analytical Chem.*, **21** (1949) pp. 1197-1200.

The authors report on a continuation of their studies of optimum distillation rates and cut points for fractions. Two solutions were distilled: one a plant stream sample containing appreciable amounts of noncondensables and C_3, C_2, C_5, C_4, and C_6 hydrocarbons. The other contained the same components, but the C_5 fraction was present in small quantity. Distillations were made at several rates, and the heart cut of each fraction was analyzed by the mass spectrometer for contamination by higher and lower boiling components. Major fractions and intermediate fractions were analyzed to determine if the generally accepted cut points were the best. It was found that distillation rates as high as 100 cc. per minute can be used with negligible contamination of fractions. If the column is properly operated, the amount of hydrocarbons distilling between the boiling points is small and the contamination of one fraction by another, when using the generally accepted cut points, is negligible. The lower boiling fraction is the usual contaminant. A detailed tabular presentation of the data is given.

Recording Infrared Spectrometer for Continuous Analysis. John U. White and Max D. Liston, and R. G. Simard. *Analytical Chem.*, **21** (1949) pp. 1156-61.

For good control of most chemical processes the concentration of several components must be known. For example in the catalytic dehydrogenation of butenes it is essential to know not only the amount of butadiene produced but also how much feed stock was consumed in the process. A Perkin-Elmer recording infrared spectrometer was adapted for use in the continuous determination of six components in a flowing stream of sample. The percent absorption at each of six key absorption wave lengths is recorded every 5.75 minutes, using the energy at six selected reference wave lengths to determine I_o. The instrument is stabilized and compensated for effects of extraneous variables. The physical arrangement of the equipment is described and typical results are presented. A bibliography of 19 references is included.

The Corrosive Sulphur Test. G. Claxton and K. H. V. French. *Jour. Inst. of Petroleum*, **35** (1949) pp. 496-507.

By an addition to the copper-strip test it has been possible to study the corrosion of copper by motor fuels on a more quantitative basis than before. This procedure depends upon conversion of the sulphide stain on the strip to hydrogen sulphide, which is estimated colorimetrically. It is known that corrosion caused

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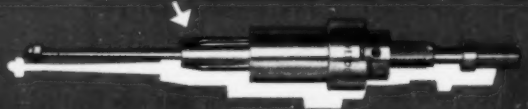

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by elementary sulphur is not proportional to the quantity of sulphur present, because of the effect of corrosion inhibitors. Corrosion by hydrogen sulphide is not affected by inhibitors. The mutual corrosion by hydrogen sulphide and elementary sulphur has been further studied on a quantitative basis. This is important if fuels are to be blended, and also in relation to storage. Contamination of stocks by hydrogen sulphide, coming from bacterial reduction of sulphates in tank-water bottoms, may be of greater importance than heretofore thought. The inhibitor most commonly present in fuels containing benzoles appears to be a peroxide of either cyclopentadiene or its dimer. The quantity of this substance causing inefficiency is extremely small and cannot be detected by the starch-iodide reaction. Details of the new apparatus and procedure are presented along with detailed tabulation of the experimental results. A bibliography of 13 references is included.

Effect of Oil on Plastic Properties of Petroleum Waxes. Development of Plasticity Tests. W. L. NELSON AND L. D. STEWART. *Ind. Eng. Chem.*, **41** (1949) pp. 2231-38.

Oil has an effect on the properties of wax, particularly the microcrystalline waxes. The authors report on the result of studies of thirty blends of technical white oil with three typical waxes as regard melting point, penetration, crystallinity index, plastic point, ductility, tensile strength, compressive strength, and flexibility. Tests were made in accordance with procedures developed, although several of the test methods are only modifications of standard methods. Equipment and procedure for a flexibility test were developed whereby a wax stick was bent through a 60° angle until rupture occurred. Tests of compressive strength were found more reliable than those of tensile strength. Oil appears to enter the space between the interlocking crystals of paraffin wax, thus altering the structure only by dissolving some of the wax. In contrast, oil enters and dilutes the continuous phase of microcrystalline waxes and thereby gradually alters the properties of the wax and possibly precipitates additional microcrystals. Only in the case of extremely hard or high melting point microcrystalline waxes does the oil improve the plasticity or flexibility of the wax. The authors use "plasticity" as the ability of a material to be deformed without rupture and to retain the new form. A bibliography of 21 references is appended.

The Measurement of Kinetic Boundary Friction With Reference to Specifications For Lubricating Oils. F. T. BARWELL AND A. A. MILNE. *Jour. Inst. of Petroleum*, **35** (1949) pp. 455-84.

Measurements of kinetic boundary friction are discussed in relation to their utility in characterizing the "oiliness" of a lubricant. "Oiliness" is not a unique property of a lubricant. Friction varies widely with such factors as speed of sliding, roughness, hardness of surfaces, and temperature. The most difficult feature of the problem is the effect of the nature of the rubbing surfaces on the value of the coefficient of friction. The large number of apparently disconnected factors

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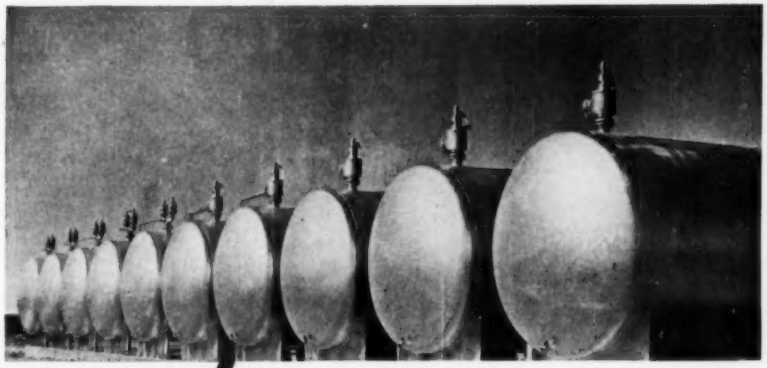
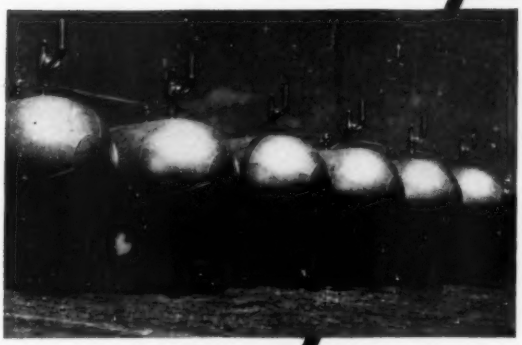
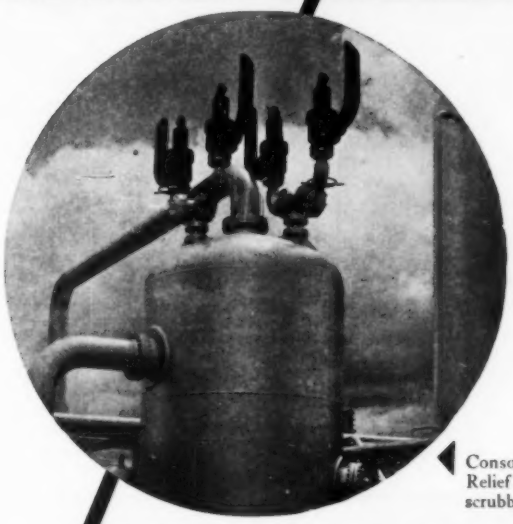


Consolidated Safety Relief Valves on propane and butane storage tanks.





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that affect the measured value of the coefficient of kinetic boundary friction renders the formulation of a general specification a matter of great difficulty. The authors confine themselves to experimental facts, as it is considered premature to introduce theories of the underlying mechanism of boundary lubrication. They recognized a possibility, however, that a sufficiently general theory would enable the number of parameters to be materially reduced an the problem of specification thereby considerably simplified. It must not be overlooked that, under mixed conditions of lubrication, it is possible that such factors as thermal expansion, viscosity-pressure effects, and others may be as important in reducing friction and wear as would be a low coefficient of kinetic boundary friction. A bibliography of 21 references is included.

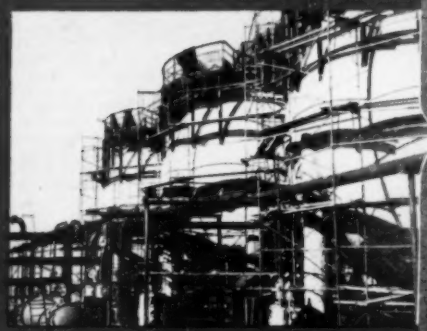
Antiknock Quality Requirements. High Compression Ratio Passenger Car Engines. R. W. Scott, G. S. Tobias and P. L. Haines. *Ind. Eng. Chem.*, **41** (1949) pp. 2342-47.

Automobile manufacturers have progressively increased the compression ratio and higher antiknock gasolines have become available. Between 1927 and 1941 the Motor octane number of regular gasolines increased from 55 to 75. During this same period the average compression ratio of new automotive engines increased from 4.4 to 6.6 to 1. In order to determine the antiknock quality requirements of high compression ratio engines, those antiknock studies employing the Borderline technique were made of 16 gasolines varying in composition, octane number, and tetraethyllead content in four cars having engines designed to operate at compression ratios of 8.0 to 12.5. Similar studies were made using two cars of present day design, one having 7.5 and the other 9.0-to-1 compression ratio engine. The antiknock requirements of the engines in terms of laboratory octane numbers may be roughly stated as a function of compression ratio varying at sea level from 93 Research octane number for 8.0-to-1 compression ratio to 102 Research octane number for 12.5-to-1 compression ratio. In high compression ratio engines the research octane number requirement is limiting, and fuels of greater sensitivity apparently can be tolerated as the compression ratio is increased. Data are presented in 10 figures and 11 tables.

An Ignition Delay Meter for the Determination of Cetane Number. H. J. Hulf, A. Rubach and J. G. Withers. *Jour. Inst. of Petroleum*, **35** (1949) pp. 485-95.

The authors state that the instrumentation standardized for use with the ASTM fixed-delay method of cetane number determination is not entirely satisfactory in use. An alternative was sought that would be more accurate and yet simple and reliable so that it could be handled by relatively unskilled operators. The new instrument is described in the paper. Beginning of combustion and injection are detected by utilizing the modified output wave forms of two electro-magnetic pick-up units. Pulse techniques enable a meter reading of ignition delay to be obtained in terms of crankshaft degrees. Injection advance is observed in a similar

These 3 facts are worthy of serious consideration by any refiner who is planning on increasing the efficiency of his desalting procedure.



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manner. The calibration of the instrument is unaffected by variations in engine speed. Ignition delay can be measured even under accelerating conditions. The instrument gave an accuracy of $\pm 1/4°$ and a discrimination of $\pm 1/10°$. The scatter of readings in cetane number determinations was roughly halved, and the speed of operation doubled. The authors conclude that the instrument is a satisfactory solution of the problem of cetane number determination.

Chemical Composition and Reactions

Solubility and Phase Relationships. High Molecular Weight Aliphatic Compounds in Liquid Propane. Richard Bogash and Arthur Norman Hixson. *Chem. Eng. Progress*, **45** (1949) pp. 597-601.

Propane has been applied extensively in the petroleum industry and to some extent, for the separation of fatty acids and glycerides. The investigation reported in the article was undertaken to explore more completely the possibility of using propane in other similar separations and perhaps to extend the use of propane as a selective solvent for the separation of high molecular weight compounds with a functional group other than the carboxylic group. The correlation of the critical solution temperature with effective molecular weight of the solutes has been proposed for binary mixtures of propane and a number of fatty acids and their esters. To complete the range of molecular weight covered by the correlation, the solubility and phase relationships of the myristic acid, lauric acid and their triglycerized esters were measured, and an exploratory survey was made to determine the effect of different functional groups and typical amides, amines and nitriles were used. The lower limit of effective molecular weight of the compound that will show a lower consolute point is about 460. The association of aliphatic amines and nitriles in propane solution is apparently less than that of the corresponding acid. The effect of an amino group in a compound of high molecular weight has little effect on the critical solution temperature. A bibliography of 13 references is given.

Infrared Spectra of Sulfones and Related Compounds. Kurt C. Schreiber. *Analytical Chem.*, **21** (1949) pp. 1168-72.

The infrared spectra in the region 1000 to 1500 cm. of thionyl chloride, sulfuryl chloride, sixteen different sulfones, two sulfates, two sulfonates, three sulfonic acids, three sulfonamides, and one sulfonyl chloride are given. Characteristic bands for the SO_2 group are discussed. The data are presented in considerable detail in tabular and in graphical form. A bibliography of 44 references is included.

Fischer - Tropsch Synthesis. Differential Reaction Rate Studies with Cobalt Catalyst. Robert B. Anderson, Abraham Krieg, R. A. Friedel, and L. S. Mason. *Ind. Eng. Chem.*, **41** (1949) pp. 2189-97.

The authors present differential reaction rate data for the Fischer-Tropsch synthesis using cobalt catalysts at atmospheric pressure. The rate was high in the initial part of the bed, lower and nearly constant throughout a large portion of the bed, until the reacting substances were fairly completely consumed. Within the range of relatively constant synthesis rate, the gas composition varied considerably. Primary reactions resulted in forming methane and carbon dioxide. Methane was also formed by secondary hydrocracking of higher-molecular-weight hydrocarbons and carbon dioxide by the water gas reaction. All of these reactions occurred through the catalyst bed, and their extent depended on the composition of the gas. Data are presented in detail in graphical form and a bibliography of 21 references is included.

Alkanesulfonic Acids as Catalysts in Polymerization and Alkylation. Wayne A. Proell and Chester E. Adams. *Ind. Eng. Chem.*, **41** (1949) pp. 2217-21.

The alkanesulfonic acids, containing one to four carbon atoms, were studied as catalysts for use in the polymerization of olefins and in the alkylation of aromatics. Technical grades of the acids now being produced on a pilot plant scale were employed in the work as well as methane and ethane sulfonic acids that were purified by distillation under vacuum. Alkylation ordinarily proceeds in preference to polymerization when conditions are favorable to either. In general, the acids are effective catalysts at temperatures above 60° C. At lower temperature the sulfonic acids react with normal olefins to form stable secondary esters. Data are presented that indicate that such ester formation occurs both in polymerization and alkylation. The alkanesulfonic acids are particularly suitable as catalysts for the study of polymerization and alkylation because side reactions such as hydrogen transfer and oxidation are largely absent. Polymerization of some olefins, such as isobutene and 1-pentene use products that contain all multiples of the monomer through the tetramer; other olefins, such as propylene and 2-butene, yield more heterogeneous polymers. In general, the type of polymer appears to depend to some extent upon the molecular weight of the monomer. A bibliography of six references is included.

Alkylnaphthalenes. Part V. Determination in Trinidad Petroleum. K. C. Bryant, G. T. Kennedy and Miss E. M. Tanner. *Jour. Inst. of Petroleum*, **35** (1949) pp. 508-14.

The use of specific dispersion measurements for the determination of naphthalene and its lower molecular weight homologues in straight-run gas oil is described and the limitations of the method are discussed. A gas oil from Trinidad crude was studied and the distribution of naphthalene and methylnaphthalenes in a series of fractions from a vacuum fractionation was determined by ultra-violet spectroscopic examination. Results obtained by this procedure are compared with those obtained by the specific-dispersion method and with those from earlier work on another gas oil.

Eliminations Involving Silicon. A New Synthesis of the Cyclopropane Ring. Leo H. Sommer, Richard E. Van Strien and Frank E. Whitmore. *Jour. of the Amer. Chem. Soc.*, **71** (1949) pp. 3056-60.

A new synthesis of cyclopropane is described, in which gamma elimination of silicon and halogen from two organosilicon compounds yields the hydrocarbon. Major driving forces of these gamma eliminations are nucleophilic attack on silicon, and electrophilic attack on halogen in the group being cleaved from silicon. It is an application of the concept of electron-release from silicon to electronically deficient carbon. The only essential requirement is the creation of electron-deficiency at a carbon atom that is sufficiently close to the silicon atom so it would cause release of an electron pair from silicon to carbon.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

4-Bromocyclohexanone
4-Bromo-4-methylcyclohexanone
1-Methyl-2-methylene-1,2-dihydroquinoline
1-Methyl-2-methylene-1,2-dihydrobenzothiazole
1,3,3-Trimethyl-2-methyleneindoline
1,6-Dichlorohexane
1,7-Dichloroheptane
1,7-Dibromoheptane
1,7-Diiodoheptane
1,8-Diiodooctane
1,9-Dichlorononane
1,9-Dibromononane
1,9-Diiodononane
Nonyl dodecyl benzenes
Pyrazole
2-Aminodicyclohexyl
1,2,3-Trichlorobenzene
3,5-Dimethylcyclohexanol
2-Methylimidazole
4-Methylimidazole
2,4-Dimethylimidazole

National Tube Completing Steel and Pipe Facilities

Extensive steel and pipemaking facilities have been virtually completed at the Lorain, Ohio, plant of National Tube Company, a subsidiary of United States Steel Corporation. These new facilities are "a major addition to the American steel industry and the project is of key importance in United States Steel Corporation's billion dollar coast-to-coast postwar improvement and development program."

Major units include the world's first continuous seamless pipe mill, new blooming, bar and billet mills, an entirely new Bessemer steel plant, 177 new by-product coke ovens, and a modern warehouse for pipe storage under roof. The new steelmaking facilities boost the company's rated output at Lorain to approximately 2.2 million tons annually. The new pipe mill is designed to make small size seamless pipe products ranging from 2 to 4½ inches in diameter. Capacity is 18,000 tons of pipe a month.

Fuels Testing Board Agent

Rear Admiral Burton B. Biggs, executive secretary of the Munitions Board Petroleum Committee, has been designated by the Defense Department as its representative on the Interdepartmental Board on Synthetic Liquid Fuels. The board co-ordinates testing for the military of all synthetic liquid fuels produced in Bureau of Mines plants.

COPPER ALLOY BULLETIN

CONDENSER AND HEAT EXCHANGER TUBING EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

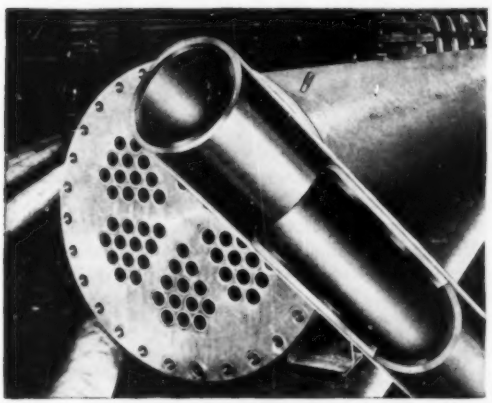
Prepared Each Month by BRIDGEPORT BRASS COMPANY "Bridgeport" BRASS CO. *Headquarters for BRASS, BRONZE and COPPER*

FIGHTING DOUBLE CORROSION

Duplex Tubing Withstands Inside and Outside Attack

Since most operations involve corrosive water solutions or oils with various concentrations of acids or alkalis, protection of equipment is a serious problem. Corrosive attack is especially troublesome in oil refining and in the processing of most chemical compounds; food and paper making, and in operations involving refrigeration, heating and air conditioning. Since equipment operates on a continuous basis, early failures through corrosion in various types of condenser and heat-exchanger tubing and pipe lines is a serious matter. This involves costly shutdowns and expensive maintenance.

Tackling Trouble Spots. Where corrosion is troublesome, operators are seriously considering Duplex Tubing especially for conditions that are not being solved satisfactorily by single-walled tubing.



Heat exchanger unit tubed with Duplex tubing. Enlarged photo shows cutaway section of tubing which has steel outside with copper inside.

Duplex Tubing, for those who are not familiar with this product, is double-walled tubing made from two different metals. Practically any combination is possible. Copper and copper-base alloys are combined with steel, stainless, aluminum, cupro nickel or monel either inside or out.

Duplex has been very successful in solving troublesome corrosion problems which occur when tubing is attacked simultaneously inside and out by two entirely different types of corrosive media. By treating such condition as two distinct corrosion problems, it is possible to select one material which can cope with the inside corrosion and another which will stand up against the outside attacker.

Oil Refining and Natural Gas. Pioneer installations of Duplex Tubing with steel to the cooling gases such as propane or butane, containing some ammonia, and red brass to the water side, are still in service after 10 years. Similar installations made since that time are equally satisfactory.

Duplex Tubing with steel to the petroleum vapors (naphtha, gasoline, fuel oil, etc.) and Admiralty or cupro nickel to the water side are also being used. Installations of Duplex with aluminum to hydrocarbon gas of high hydrogen sulphide and/or carbon dioxide content, and copper to the water side indicate that very satisfactory life will be obtained.

For oil refining and in the natural gas industry, we have supplied Duplex Tubing with steel outside to resist various corrosive petroleum vapors and copper inside toward the fresh water; steel toward the oil, and Admiralty inside toward the circulating salt water. Other applications in these industries call for combinations such as cupro nickel, red brass, copper, Admiralty or Muntz, with aluminum either outside or inside.

A case in point, involving excessive corrosion, is in a D.E.A. (diethanolamine) cooler where steel tubing is not entirely satisfactory because it fails rapidly from the water side but stands up on the product side. Here Duplex Tubing—Admiralty Brass or cupro nickel to the cooling water side and steel or aluminum to the D.E.A. should be tried out.

Duplex Tubing also shows promise in connection with mercury vapor systems with steel to the mercury side and copper-base alloy to the cooling water side.

Ammonia Refrigeration. In ammonia coolers or condensers in refrigeration and air conditioning systems, Duplex Tubing with copper to the water or brine side and with steel to the ammonia side is outlasting single wall tubing formerly used. For services of this type, copper is most popular but Admiralty and red brass (85-15) are increasing in popularity on the fresh water side. Alloys such as 70-30 cupro nickel and 80-20 cupro nickel are the most popular for contact with the sea water side.

Duplex Tubing—copper and steel—is also used in the construction of beer coolers with copper to the beer side and steel to the ammonia side.

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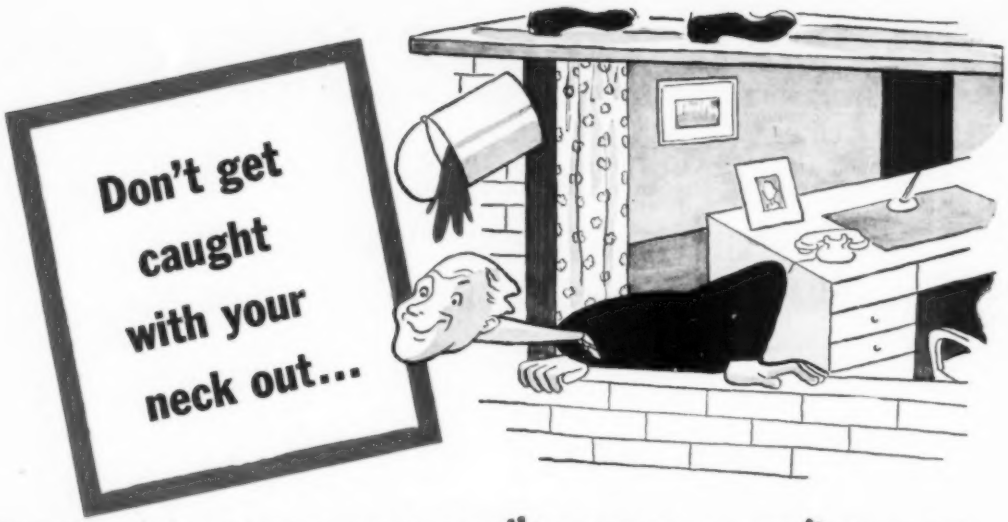

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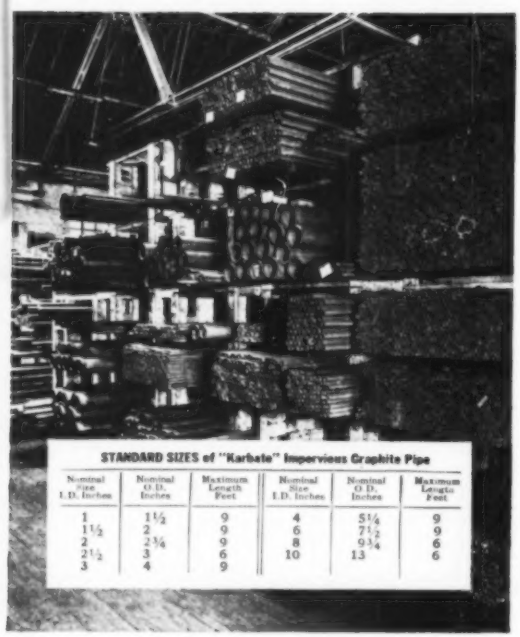

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Nominal Pipe I.D. Inches	Nominal O.D. Inches	Maximum Length Feet	Nominal Size I.D. Inches	Nominal O.D. Inches	Maximum Length Feet
1	1½	9	4	5¼	9
1½	2	9	6	7½	9
2	2¾	9	8	9¾	6
2½	3	6	10	13	6
3	4	9			

KEEP a full stock of corrosion-resistant "Karbate" Impervious Graphite Pipe in an adequate range of sizes and you will never be caught short by an emergency replacement job . . . or have to waste time ordering whenever there is a routine repair to be made. "Karbate" pipe, valves, fittings, towers, pumps, tanks and other equipment offer you many advantages:

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Digest of Recent U. S. PATENTS Pertaining to PETROLEUM REFINING

Compiled by HEINZ HEINEMANN

(From the Official Gazette, September 12, 19, 26, October 4 and 11, 1949)

CATALYST PREPARATION, ACTIVATION, AND REGENERATION

U.S.P. 2,481,493. Preparation of Silica-Zirconia Gel. R. W. Blue to Houdry Process Corporation.

Zirconium silicate refractory material is fused in an alkaline flux. An alkaline silicate is thoroughly incorporated with this melt in an amount to furnish a desired silica/zirconia ratio. The resulting mixture is dispersed in an aqueous medium, and the pH of the dispersion is adjusted to 2.5-8.0. The colloidal sol obtained is set to a hydrogel. A hydrocarbon conversion catalyst is thus obtained.

U.S.P. 2,481,824. Dehydrogenation of Hydrocarbon Oil and Catalyst Therefor. W. H. Claussen and H. E. Wellman to California Research Corporation.

A catalytic material comprising coprecipitated alumina and molybdenum oxide is mixed with 1-10 percent graphite prior to pelleting. The pellets formed are calcined for several hours at temperatures up to and including 1100° F. to remove volatile constituents but leave graphite present. The pelleted catalyst thus obtained is used in the dehydrogenation of hydrocarbons. The graphite prevents an undesirable high degree of oxidation of the molybdenum oxide during regeneration of the spent catalyst.

U.S.P. 2,481,825. Production of Synthetic Gels. G. C. Connolly to Standard Oil Development Company.

A silica hydrogel is washed first with an aqueous medium having a constant pH value in the neutral to slightly alkaline range and thereafter with an aqueous medium having a constant acid pH value. While the total length of the two washings is maintained constant, the lengths of the individual washings are varied to compensate for variations in the density of the gel products resulting from inadequate process controls and thereby to produce a product of more uniform density.

U.S.P. 2,481,841. Method of Preparing Catalyst Particles Having Nuclei of Previously Calcined Fines. C. E. Hemminger to Standard Oil Development Company.

Catalyst of a particle size smaller than the shape desired for the treatment of petroleum oils in vapor form containing a suspension of the catalyst is withdrawn from this treatment and incorporaed into fresh catalyst undergoing preparation prior to the sizing of this fresh catalyst. Improved catalysts of increased mechanical strength are thus obtained which contain nuclei of fines highly heated in a preceding hydrocarbon conversion operation.

U.S.P. 2,483,130. SiF_4-Impregnated Alumina Catalyst and Process of Preparing It. A. D. Garrison to Texaco Development Corporation.

An alumina catalyst is activated by contacting it with anhydrous SiF_4 at a temperature of 70-950° F. until the alumina absorbs 5-15 percent by weight of SiF_4.

U.S.P. 2,483,131. SiF_4-Impregnated Silica-Alumina Catalyst. A. D. Garrison to Texaco Development Company.

The process according to U.S.P. 2,483,130 is employed for the production of a silica-alumina catalyst used in the conversion of hydrocarbons.

U.S.P. 2,483,372. Heavy Gravity Liquid Separation of Porous Catalyst. J. W. Payne to Socony-Vacuum Oil Company, Inc.

The pores of cracking catalyst particles of substantially identical chemical composition but varying activity are filled with a liquid hydrocarbon. The filled particles are mixed with an aqueous liquid of a sp. g. numerically intermediate between the maximum and minimum values for particle densities of the filled particles. The floating portion of the particles is then separated from that which sinks in the aqueous liquid. After removal of the soaked-in hydrocarbon, two separate portions of catalyst of different activity are obtained.

U.S.P. 2,483,782. Preparation of Plural Silica-containing Hydrogel Catalysts. J. A. Pierce to Standard Oil Development Company.

A silica sol is allowed to thicken to a viscosity of 1000-5000 centipoises at a temperature of about 68° F. An alumina or beryllia sol is added to the thickened silica sol, whereby common precipitation of both sols is simultaneously secured with formation of a homogenous plural hydrogel useful as a conversion catalyst.

U.S.P. 2,483,850. Process of Reclaiming a Contaminated Iron Catalyst. M. A. Segura and D. R. McAdams to Standard Oil Development Company.

Powdered iron catalyst, contaminated with carbonaceous solids tending to cause fragmentation of the catalyst and present to such an extent that the catalyst cannot be wetted by water, is first treated with an oxygen-containing gas under conditions suitable to reduce the carbonaceous content of the catalyst to 5-30 percent by weight. The catalyst is then cooled to a temperature below the boiling point of water and mixed with a sufficient amount (e.g. 18-20 percent by weight) of water to form a moist, loosely compacted mass which is sintered at a temperature of 2000-2200° F. for ½ to 2 minutes for recovering the catalyst.

U.S.P. 2,483,868. Method of Preparing Silica Gel which Involves Atomizing Sodium Silicate into Acid. J. R. Archer and G. Dunn to International Minerals and Chemical Corporation.

Sodium silicate solution is introduced in atomized form into a turbulently agitated sulfuric acid solution. The resultant gel is washed and dried. It contains about 94 percent silica.

U.S.P. 2,484,258. Hydrocarbon Cracking Catalyst and Process. G. M. Webb and R. W. Moehl to Universal Oil Products Company.

Silica is composited with a metal oxide, e.g. alumina. The composite is heated at a temperature of 700-1300° F. and then suspended in an aqueous solution of ammonium hydroxide at a temperature not in excess of about 300° F. A cracking catayist is obtained.

U.S.P. 2,484,284. Process of Gelation. C. I. Glassbrook and R. C. Hansford to Socony-Vacuum Oil Company, Inc.

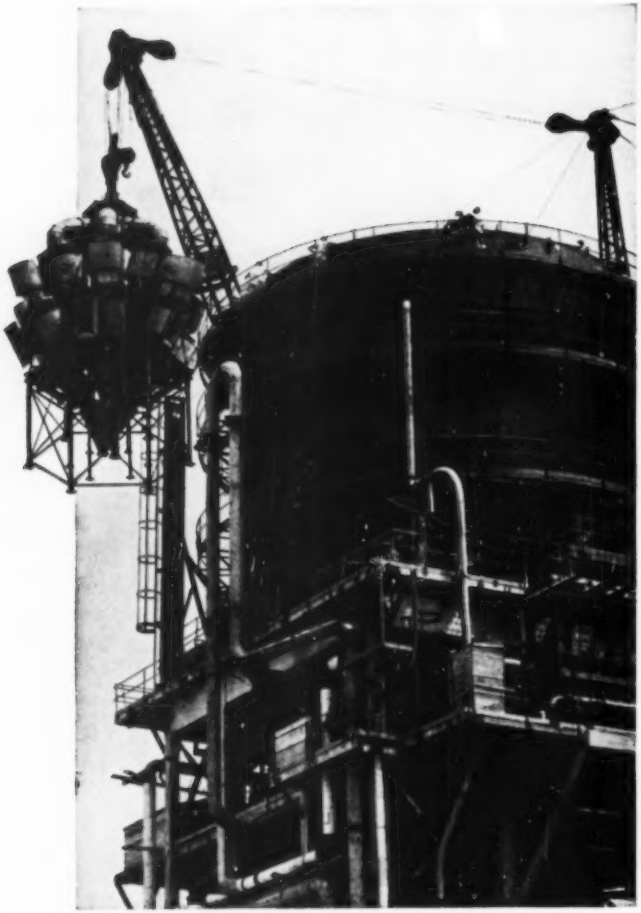
An inorganic oxide hydrosol capable of setting to a gel is subjected to a uni-directional electrical field of orientation during the gelation. The resulting gel is washed free of water-soluble salts and dried. Cracking catalysts of improved catalytic properties are obtained.

REFINING

U.S.P. 2,481,570. Refining of Liquid Hydrocarbons. A. Champagnat to Soc. Generale des Huiles de Petrole.

In the extraction of mercaptans from

BUELL 'GOES TO THE TOP'
in catalyst recovery



In fluid or thermofor catalytic cracking Buell recovery systems have demonstrated continuous high-efficiency performance in all the major refineries. Design information is available on the latest multi-stage collectors. Buell Engineering Company, 70 Pine Street, Suite 5070, New York 5, N. Y.

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hydrocarbons by washing with a solution of an alkali metal hydroxide containing a solutizer, a salt of sodium or potassium with sulfonic acids is employed as the solutizer. The sulfonic acids employed are present in the acid tars forming a by-product of certain acid-refined distillation products of crude petroleum oils.

U.S.P. 2,481,734. Isolation of Styrene by Azeotropic Distillation. K. H. Engel to Allied Chemical & Dye Corporation.

A hydrocarbon oil containing styrene and at least one like-boiling non-styrene aromatic component, such as phenylacetylene, is fractionally distilled in admixture with 1-nitropropane. An azeotropic mixture of the non-styrene aromatic with 1-nitropropane is separated and an oil with substantially greater styrene content is recovered.

U.S.P. 2,481,816. Method of Finishing Aromatic Concentrates. J. G. Browder, R. M. Love, H. G. Schutze, and R. E. Tannich to Standard Oil Development Company.

A hydrocarbon oil comprising a major portion of aromatics and a minor portion of olefins, as obtained in a catalytic dehydrogenation process, is treated with concentrated H_2SO4 and thereafter with a caustic soda solution in a manner claimed in detail. An alkali metal salt of a petroleum naphthenic acid is added to the oil obtained by this treatment. On distilling the resulting mixture at temperatures not higher than 525° F., a side-stream of the desired aromatic concentrate is obtained which is then stabilized by admixture with an inhibitor.

U.S.P. 2,481,843. Extraction of Aromatics with Aluminum Halide-Aromatic Complexes. P. H. Holt, II, and N. Menshih to Standard Oil Development Company.

A mixture of aromatic and non-aromatic hydrocarbons is contacted with an aluminum halide-aromatic hydrocarbon complex containing at least 1 molecule of the aromatic on 2 molecules aluminum halide. A complex of increased aromatic content (up to 6 molecules on 2 molecules of the halide) thus formed is withdrawn and decomposed to recover the aromatics and regenerate the original complex compound.

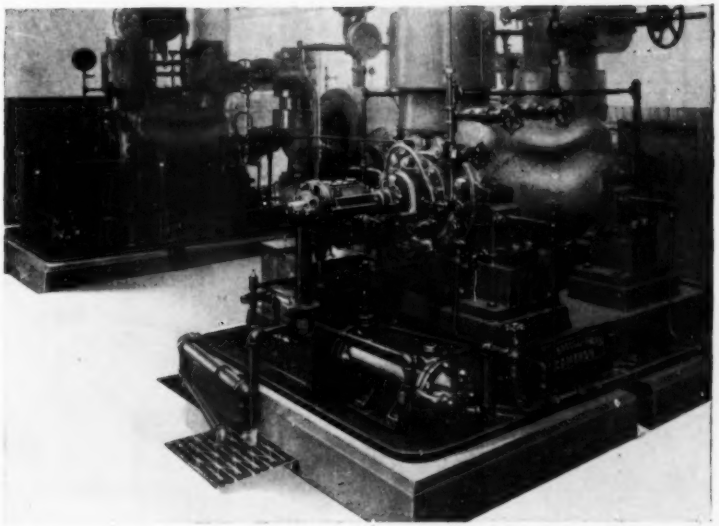
U.S.P. 2,483,492. Purification of Benzene and Homologues Thereof. H. J. Hepp to Phillips Petroleum Company.

An olefin-containing monocyclic aromatic hydrocarobn is liquid-liquid extracted with liquid $AlCl_3$-hydrocarbon complex having a heat of hydrolysis of 200-480 calories per gram to effect the removal of the olefin in the form of an olefin-containing $AlCl_3$-hydrocarbon complex. Details of this method are claimed.

U.S.P. 2,483,625. Two-stage Azeotropic Distillation of Nonaromatic Hydrocarbons from Toluene. R. Cubicciotti to Union Oil Company of California.

Non-aromatic hydrocarbons with boiling point close to that of toluene are separated from the latter by azeotropic distillation in the presence of an azeo-

How much time do your refinery pumps save?



These two I-R hot-oil pumps at the Magnolia Petroleum Company's Beaumont refinery in Texas saved plenty of time—*maintenance time*. One pump operated over 12 years, the other 10 years, before being opened for inspection. And then only minor repairs were necessary to put them back on stream.

The record of these two pumps, both of which, since 1936, have been handling oil at 750°F against a high discharge pressure definitely proves the *"less time out for maintenance"* feature of Ingersoll-Rand pumps . . . a feature that helps to reduce over-all production costs. Under today's conditions, this feature is more important than ever.

It's a good idea to confer with an I-R engineer before buying a pump for *any* refinery application. He'll be glad to point out the features of I-R pumps that mean year after year dependability . . . *and with the least amount of time out for maintenance.*

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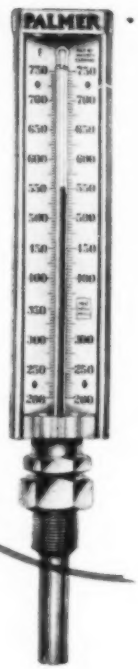
Above: An oil field oil-water emulsion heater, with Palmer Thermometers "on guard"



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trope former, such as methyl alcohol, and by thereafter subjecting the distillation residue to further azeotropic distillation in the presence of methyl ethyl ketone. Toluene substantially free from non-aromatic hydrocarbons is left in the second residue.

U.S.P. 2,483,778. Inhibition of Resin Growth from Diolefins. C. E. Morrell and R. F. Robey to Standard Oil Development Company.

Olefinic hydrocarbons with a tendency to form insoluble self-propagating polymers are handled until a small amount of such polymer is formed. This polymer is separated from the olefins and then treated with a reactant capable of being added to an olefinic linkage, e.g. a vulcanizing accelerator, whereby further growth of the polymer is inhibited. The thus treated polymer is then contacted with the olefinic hydrocarbons.

U.S.P. 2,483,863. Diolefin Extraction. S. W. Wilson to Standard Oil Development Company.

Olefin-containing hydrocarbon mixtures are contacted with an ammoniacal cuprous acetate solution. The resulting solution containing absorbed olefins is separated from the undissolved hydrocarbons and both portions are subjected to further treatment while washing with water in a manner claimed in detail, to recover olefins, other hydrocarbons, and ammonia. Corrosion of the iron equipment is inhibited.

U.S.P. 2,483,869. Treatment of Hydrocarbons. P. M. Arnold to Phillips Petroleum Company.

A relatively low-boiling hydrocarbon, particularly ethylene, is separated from a hydrocarbon mixture by a process claimed in detail and comprising repeated fractional distillation under different conditions.

U.S.P. 2,484,205. Apparatus for Treating Crude Oil Emulsions. A. V. E. Candler to Maloney-Crawford Tank & Manufacturing Company.

Details of an apparatus are claimed for treating petroleum emulsions, particularly for breaking the emulsions and freeing the oil, and also for separating out the water and gas in the mixture.

U.S.P. 2,484,257. Stabilization of Organic Substances. R. W. Watson and C. M. Loane to Standard Oil Company of Indiana.

To a hydrocarbon oil susceptible to oxidation deterioration in the presence of metals and metal compounds is added a small amount of an organic dithiocoxamide. The additive suppresses the oxidative catalyzing effect of the metals.

U.S.P. 2,484,304. Method of Dewaxing Oil and Continuous Rotary Filter Therefor. W. C. Long and H. O. Button to Socony-Vacuum Oil Company, Inc.

Wax is removed from mineral oil slurry in a closed continuous filter. A wax filter cake is formed and washed upon a travelling surface within the filter chamber. The cake is then dislodged by blowing gas therethrough. The dislodged cake is removed from the filter surface by scraping with a perforated blade and

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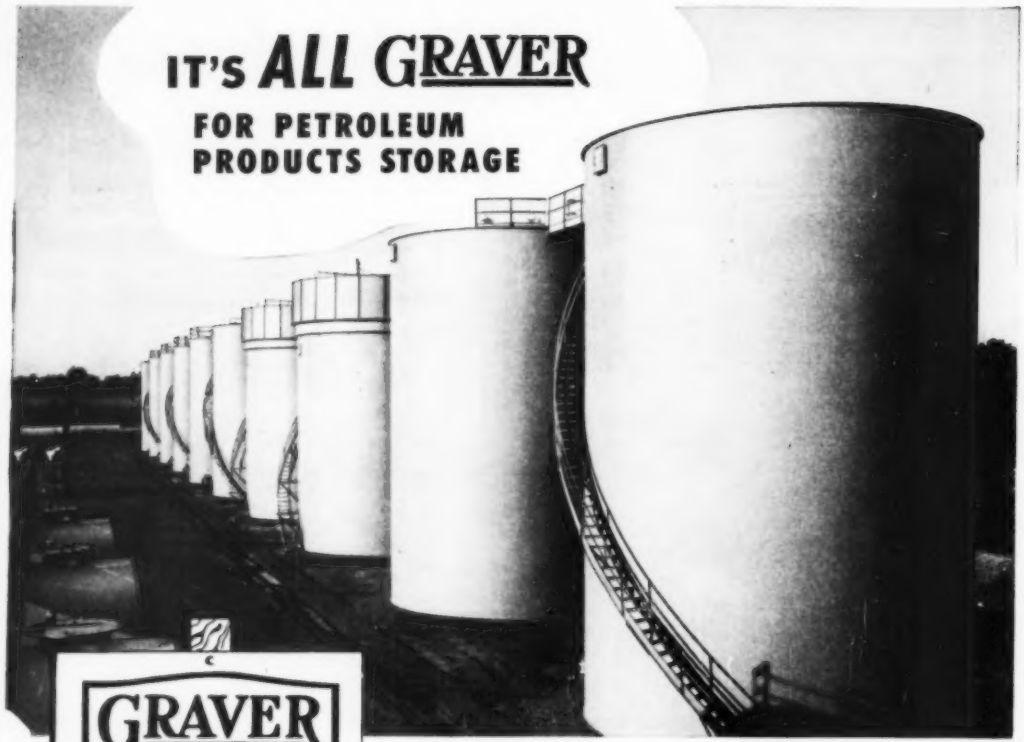

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is conducted along the upper surface of this blade. Oil contained in the cake is permitted to pass through the perforated blade and is returned to the feed slurry.

U.S.P. 2,484,305. Process for the Separation of Unsaturated Aliphatic Hydrocarbons from More Saturated Aliphatic Hydrocarbons. B. J. Mayland and E. E. White to Phillips Petroleum Company.

A hydrocarbon mixture containing aliphatic unsaturated hydrocarbons with 1-2 double bonds and more saturated aliphatics is separated into a fraction rich in more saturated and a fraction rich in more unsaturated hydrocarbons. The mixture is contacted with a liquid selective solvent for the more unsaturated hydrocarbons consisting essentially of ethanolamine saturated with tetraethyl-orthosilicate or of paraldehyde, or the like.

ALKYLATION

U.S.P. 2,482,084. Alkylating Thiophene with Sulfuric Acid Catalyst. P. D. Caesar and P. G. Waldo to Socony-Vacuum Oil Company, Inc.

Thiophene homologues are produced by reacting a thiophene compound with at least one replaceable hydrogen atom in the nucleus in the presence of aqueous H_2SO_4 of 45-75 percent concentration at temperatures of 55-300° C. with an acylating agent.

POLYMERIZATION AND CONVERSION

U.S.P. 2,481,838. Preparation of Synthetic Rubber Lattices. G. U. Glasgow to U. S. Rubber Company.

Butadiene-1,3 or a mixture thereof with a compound containing a single $CH_2=C<$ group is emulsion polymerized in the presence of .05-.5 percent by weight of casein acylated by fatty acids. The viscosity of the resulting latex is greatly reduced by the addition of the acylated casein in the polymerization reaction.

U.S.P. 2,482,008. Process for Polymerization of Propylene. E. V. Kleber to Sharples Chemicals Inc.

Tetramethyl ethylene is produced by continuous dimerization of propylene in a process claimed in detail wherein propylene freed from higher boiling admixtures is flowed through a bed of activated clay for a contact time of 1-20 seconds.

U.S.P. 2,482,137. Process and Apparatus for Converting Hydrocarbons. A. H. Schutte to The Lummus Company.

Liquid hydrocarbons are converted in the presence of a compact column of moving particle-form contact material in an upright conversion zone. The contact material is introduced into the upper section of this zone in a plurality of confined streams delivering onto the surface of the column as a series of flowing piles assuming approximately the angle of repose. A stream of the hydrocarbon charge is applied to the discrete bed particles of each stream

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laterally between the streams and while in their movement as flowing piles.

U.S.P. 2,482,138. Reactor for Thermal Conversion of Hydrocarbons. A. H. Schutte to The Lummus Company.

A reactor is claimed for thermal contact conversion of hydrocarbons in the presence of a granular contact material moving by gravity flow downwardly through the reactor. Means are provided for uniformly distributing hot hydrocarbon fluid to the continuously moving contact bed.

U.S.P. 2,482,139. Hydrocarbon Conversion. A. H. Schutte to The Lummus Company.

A plurality of confined streams of particle form contact material is introduced at conversion temperature into the upper end of a vertically elongated conversion zone, said confined streams having an appreciably smaller cross-sectional area than the compact column of the contact material moving downward through this zone. A vapor collecting space is formed between the series of flowing piles of contact material extending to the upper end of the compact column. Streams of heavy liquid hydrocarbon charge are injected into opposite sides of the upper portion of each flowing pile of contact material and vaporous hydrocarbon products are withdrawn through the flowing piles and out of the vapor collecting space.

U.S.P. 2,482,140. Method for Hydrocarbon Conversion. A. H. Schutte to The Lummus Company.

The process according to this patent is somewhat related to that of U.S.P. 2,482,139. The particle form contact material is introduced in the present case into the upper end of the conversion zone in a confined, compact stream of substantially smaller cross-section than the downwardly moving compact column, and the liquid hydrocarbons are introduced into said stream near its lower end.

U.S.P. 2,482,877. Polymerization of Ethylene. L. Schmerling to Universal Oil Products Company.

Ethylene is subjected to polymerization conditions in the presence of an organic peroxide catalyst at a temperature 25-150° C. higher than the initial decomposition temperature of the catalyst and in the presence of an inert gas and a diluent consisting of at least one saturated hydrocarbon with at least 3 C atoms. Normally liquid ethylene polymers are produced.

U.S.P. 2,483,487. Separation of Volatilizable Metal Halides from Adsorbents. S. C. Carney to Phillips Petroleum Company.

A volatile Friedel-Crafts metal halide employed as a catalyst in the conversion of hydrocarbons and carried by an inorganic adsorbent is desorbed from this carrier by passing over this material under suitable conditions of temperature and pressure an anhydrous vaporous stream of a gas substantially non-reactive with the metal halide under the condition of use, in admixture with a hydrogen halide, the halogen of which corresponds to that of the metal halide. The hydrogen halide partial pressure is progessively increased during this treatment, effecting more complete desorption. A low-boiling saturated hydrocarbon can be used as the non-reactive gas of the desorbing mixture.

U.S.P. 2,483,877. Method and Apparatus for Continuous Polymerization. S. C. Carney to Phillips Petroleum Company.

Continuous polymerization of unsaturated organic material, e.g. isobutylene, to solid form is effected by applying a relatively thin film of the liquid material to an elastic flat supporting belt which is continuously fed into a closed vessel where the material is subjected to polymerization conditions. Details of this process are claimed.

U.S.P. 2,483,886. Catalyst Comprising Dispersed Alkali Metal and Carbon Black, and Polymerization Process Employing Said Catalyst. W. W. Crouch to Phillips Petroleum Company.

Diolefins are polymerized, if desired in admixture with other polymerizable compounds, by means of a catalyst which comprises a dispersion of finely divided alkali metal in an inert liquid dispersing medium containing 2-20 per cent by weight (based on the alkali metal) of carbon black as a dispersing agent. Hydrocarbons e.g. aromatics, can be used as the dispersing medium. Mass production of polymers of great uniformity and superior properties is made possible by this process.

U.S.P. 2,483,887. Catalyst Comprising Dispersed Alkali Metal and Alkali Metal Mercaptide, and Polymerization Process Employing Said Catalyst. W. W. Crouch to Phillips Petroleum Company.

The polymerization process according to this patent differs from that of U.S.P. 2,483,886 essentially only in that in the present case a mercaptide of the alkali metal employed as the catalyst is contained in the dispersion instead of the carbon black. Xylene is the preferred dispersing medium in this case.

U.S.P. 2,484,384. Polymerization Process. I. E. Levine and L. T. Folsom to California Research Corporation.

Details are claimed of a process for the production of high molecule weight olefin polymers in the presence of a solution of a Friedel-Crafts type solid metal halide catalyst in an inert aliphatic hydrocarbon, such as butane.

HYDROGENATION, DEHYDRATION, AROMATIZATION

U.S.P. 2,481,921. Catalytic Hydrogenation of Naphthalenes. M. H. Gwynn to Allied Chemical & Dye Corporation.

Details of a process are claimed for the vapor phase catalytic hydrogenation of crude naphthalenes containing sulfur compounds. Tetrahydro and decahydro naphthalenes are produced.

U.S.P. 2,482,187. Process for Producing Hydrogen-Carbon Monoxide Gas Mixtures. E. A. Johnson to Standard Oil Company of Indiana.

A fluid mass of finely divided carbonaceous solids is heated by the exothermic conversion of carbon with oxygen-containing gas to carbon oxides. The unconverted incandescent solids remaining are transferred to a decomposition zone wherein they serve both to supply heat and reactant material for endothermic decomposition of steam admixed with methane and oxygen. Details of this process for the production of Fischer-Tropsch synthesis gas are claimed.

U.S.P. 2,482,284. Production of Oxygenated Compounds and Liquid Hydrocarbons from Hydrocarbon Gases. V. F. Michael and J. A. Phinney to Stanolind Oil & Gas Company.

Gaseous hydrocarbons, e.g. natural gas, are partially oxidized in the absence of a catalyst. The resulting stream of oxygenated organic compounds, carbon oxides, and residual gaseous hydrocarbons is scrubbed to remove the oxygenated compounds. The residual hydrocarbons are reacted with an oxidizing gas to produce H_2 and CO which are used for the hydrocarbon synthesis. Details are also claimed for separating a liquid hydrocarbon phase, a gaseous hydrocarbon phase, and a water phase containing oxygenated compounds formed.

U.S.P. 2,482,866. Production of Carbon Monoxide and Hydrogen. J. A. Phinney to Stanolind Oil & Gas Company.

A gaseous hydrocarbon including methane and an oxygen-containing gas are contacted with finely divided catalytic solids comprising a group VIII metal in a dense turbulent suspended phase at a pressure of about 30 psi. gauge. About 0.6 mole of oxygen is employed per mole of methane to attain an equilibrium reaction temperature of about 1530° F. favoring the conversion of the methane to about 92 percent H_2 and CO in the molal ratio 2:1. The catalyst is maintained at the equilibrium reaction temperature by supplying the reactants at a temperature sufficiently below this temperature to extract exothermic reaction heat, and by withdrawing reaction effluent from the reaction zone at the equilibrium temperature.

U.S.P. 2,483,132. Conversion of Hydro-Carbon Gas into Carbon Monoxide and Hydrogen. L. P. Gaucher to The Texas Company.

In the continuous partial combustion of hydrocarbon gas with a limited quantity of oxgen sufficient to produce maximum amounts of CO and H_2, the oxygen is divided into major and minor streams. The mixture of the major oxygen stream with hydrocarbon gas and the minor oxygen stream are heated and separately passed to a combustion zone, where they are mixed to effect the partial combustion. Coke accumulation is prevented by this method and increased yields of CO and H_2 are obtained.

U.S.P. 2,483,485. High Velocity Fluids Solids Technique. F. T. Barr to Standard Oil Development Company.

Carbon monoxide and hydrogen are contacted under synthesis conditions with a dense turbulent fluidized mass of synthesis catalyst with a particle size of 20-80 microns. Upwardly flowing volatile reaction products, gasiform reactants, and entrained catalyst are with-

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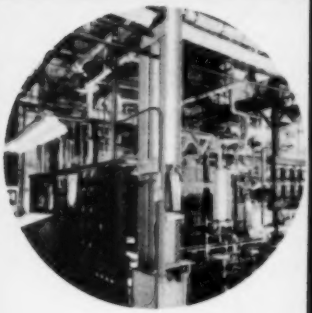
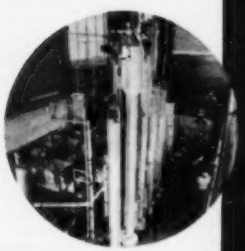
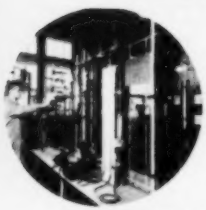


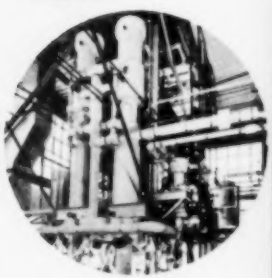
Vacuum Distillation



Precise Fractionation



Analytical Distillation



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drawn and passed into an elevated reaction zone of fluidized solids comprising synthesis catalyst with an average particle size appreciably greater than 80 microns to about 2500 microns. Volatile reaction products and reactants are withdrawn from this zone substantially free of entrained catalyst.

U.S.P. 2,483,494. Catalytic Converter, C. E. Kleiber, D. L. Campbell, D. E. Stines, and C. C. Nelson to Standard Oil Development Company.

The reactor claimed in detail is useful for carrying out high temperature short time catalytic reactions, particularly the dehydrogenation of butanes to form butadiene with maximum yield. The reaction time and the time the reactants and products are maintained at high temperature are closely controlled in this reactor.

U.S.P. 2,483,512. Hydrocarbon Synthesis Process Catalyzed by Oxidized and Reduced Iron. A. Voorhies, Jr., and J. J. Owen to Standard Oil Development Company.

A mixture of CO and H_2 is contacted under synthesis conditions with a catalyst prepared by oxidizing powdered iron at a temperature of 600-900° F. and thereafter reducing the product with a hydrogen-containing gas at the same temperature. The product obtained is rich in oxygenated hydrocarbons.

U.S.P. 2,483,771. Two-Stage Process for the Synthesis of Hydrocarbons. C. H. Holder to Standard Oil Development Company.

A mixture of CO and H_2 is contacted under synthesis conditions with a dense, turbulent mass of a finely divided iron catalyst promoted by alkali metal salt. The withdrawal product stream contains entrained partially oxidized iron catayist particles of less than fluidizable size. The catalyst particles are scrubbed from this stream with a liquid forming a slurry with these particles. This slurry is introduced into a second CO-H_2-synthesis reaction zone, where further amounts of hydrocarbons and oxygenated hydrocarbons are produced by means of this slurry-form catalyst working in a foam-phase operation.

U.S.P. 2,483,929. Catalytic Hydrocarbon Conversion. J. R. Owen to Phillips Petroleum Company.

Hydrocarbons are subjected to dehydrogenating conditions in the presence of a catalyst comprising 5-20 percent BeO, 5-40 percent Cr_2O_3, and 40-90 percent Al_2O_3. The catalyst is formed by separately dissolving salts of these metals in a quantity of water not substantially in excess of that required for obtaining a saturated solution. Alkali is added to these solutions in amounts insufficient to effect precipitation of the metal ion as hydroxide but sufficient to form the hydrosol. After mixing the hydrosols sufficient alkali is added to coprecipitate completely the respective hydrous oxides which are gradually heated to about 500° C. to effect complete conversion to the metal oxides. The new dehydrogenation catalyst shows great resistance to destruction of the amorphous gel structure and exhibits a large surface area per unit of mass.

U.S.P. 2,484,249. Preparation of Gas

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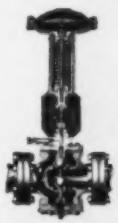

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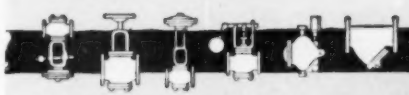

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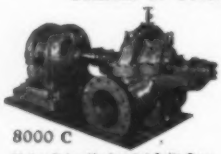


8000 C

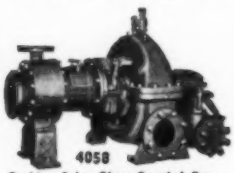
Motor Drive Horizontal Split Case Double Suction Centrifugal Pump

8001

Turbine Drive Horizontal Split Case Multi Stage Centrifugal Pump

4049 A

Two Stage Close Coupled Centrifugal Pump



4058

Turbine Drive Close Coupled Centrifugal Pump

942

Single Style, Packed Piston Pattern Steam Pump

2352 B

Durable Duplex, Outside End Packed, Plunger Pattern Steam Pump

3918

Durable Duplex, Packed Piston Pattern Steam Pump

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Horizontal Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump

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Patents

Mixture. R. J. Ruble to Texaco Development Corporation.

A mixture of CO and H_2 is prepared by the partial combustion of a hydrocarbon by an oxygen-containing gas in an internal combustion engine. Details of the method are claimed.

ISOMERIZATION

U.S.P. Re 23,151. Isomerization of Cycloparaffins of Nonhydroaromatic Structure. R. M. Shiras, A. C. Nixon, and C. H. Deal, Jr., to Shell Development Company.

Details of a process are claimed for the production of cycloparaffins of hydroaromatic structure, such as cyclohexane, free of substantial amounts of aromatic hydrocarbons, from a hydrocarbon fraction comprising cycloparaffins of hydroaromatic and nonhydroaromatic structure in admixture with close boiling open chain paraffin and aromatic hydrocarbons. After repeated extractive distillation and fractionation, a cycloparaffin fraction of non-hydroaromatic structure is obtained and is isomerized to form cycloparaffins of hydroaromatic structure.

U.S.P. 2,482,145. Method for Isomerization. J. A. O. Antheaume to Compagnie Francaise de Raffinage.

Normal butane is isomerized in the presence of a catalyst consisting of a binary mixture of at least 90 percent of $AlCl_3$ and an alkali metal chloride. The reaction temperature is preferably higher than 107° C. Improved yields in isobutane are obtained.

HEAVY OILS AND WAXES

U.S.P. 2,481,487. Lubricating Composition. D. E. Adelson to Shell Development Company.

Mineral lubricating oil is compounded with a minor amount of a reaction product obtained by reacting below 200° C. P_2S_5 with unsaturated cyclic ketone fractions having at least 12 C atoms, and thereafter treating the resulting product at a temperature below 180° C. with sulfur. The additive thus obtained contains 1.2-5.2 percent P and shows 32-73 percent increase in S content above that present in the initial reaction product. The additive stabilizes the lubricant against deterioration and corrosion.

U.S.P. 2,481,498. Preparation of Drying Oil by Polymerization of Olefins. P. H. Carnell to Phillips Petroleum Company.

A mixture of anhydrous HF and an olefin is polymerized at a temperature of 0-150° C. The resulting mixture is fractionated to separate HF and unpolymerized olefin. The remaining polymer is further polymerized at a temperature of 100-200° C., but higher than that employed before, for a period of 15 minutes to one hour. A drying oil is formed.

U.S.P. 2,481,585. Lubricating Oil Composition. M. W. Freeman.

A mineral lubricating oil has incorporated therein a complex co-reaction

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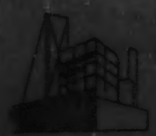

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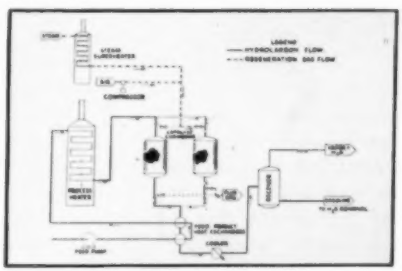
*A SERVICE MARK

Our Perco engineering staff will gladly study your sour natural gasoline situation. We will suggest a Perco Octane Insurance Program to improve the sales appeal of your product both now and in the future—by using the Perco Catalytic Desulfurization Process.



Perco Catalytic Desulfurization Process

Phillips 66

PHILLIPS PETROLEUM COMPANY

PERCO DIVISION • CHEMICAL PRODUCTS DEPARTMENT

BARTLESVILLE, OKLAHOMA

PROFIT WITH PERCO PROCESSES

product obtained from an organic nitrogen base, a monocarboxylic acid, and an oxidized mixture of an organic sulfonate with a hydrocarbon lubricating body. The lubricant has extreme pressure properties.

U.S.P. 2,481,859. Diesel Fuel. P. Miller to Standard Oil Development Company.

A fuel for compression ignition engines of the Diesel type consists of a hydrocarbon fuel containing .025-5 percent of tert. butyl perbenzoate. The additive is stable in storage and increases the cetane number of the fuel sufficiently so that it can be used in high speed engines.

U.S.P. 2,482,517. Corrosion Inhibiting Composition. K. F. Schiermeier and W. E. Heinz to Shell Development Company.

A mineral oil composition contains at least 0.5 percent by weight of a partial ester of an acyclic polyhydric alcohol and an aliphatic acid with 10-40 C atoms. The partial ester has at least two free hydroxyl radicals separated from each other by not more than 3 directly connected atoms and has a melting point below 200° F. This additive is solubilized in the mineral oil by an oil-soluble salt of an organic sulfonic acid. The composition is storage-stable, the additive inhibiting corrosion.

U.S.P. 2,482,762. Lubricating Compositions. M. B. Goren to Shell Development Company.

A liquid hydrocarbon contains a stabilizing amount of a P- and S- containing reaction product obtained by reacting phosphorus sulfide and a cyclic ketone fraction with at least 12 C atoms. The additive prevents deterioration and improves the anti-wear properties of the hydrocarbon oil.

U.S.P. 2,483,270. Lubricating Composition. P. W. Fischer to Union Oil Company of California.

Mineral lubricating oil contains a small amount of an oil-soluble metal salt of the reaction product of a phosphorus sulfide or oxide with a sulfonic acid. This reaction product is obtained by reacting the sulfonic acid with 3-50 percent of the phosphorus compound at 100-400° F. The additive improves the lubricating properties under conditions of severe service.

U.S.P. 2,483,282. Art of Grease Manufacture. H. G. Houlton to The Girdler Corporation.

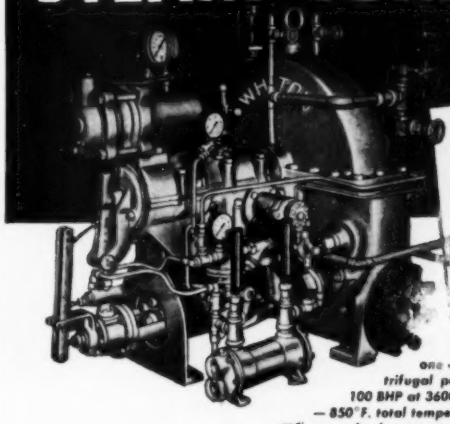
Details are claimed of a process for the manufacture of grease from mineral oil and a stiffening agent with cooling of the grease below the transition temperature.

U.S.P. 2,483,499. Lube Oil Additives and Preparation Thereof. E. Lieber and A. F. Cashman to Standard Oil Development Company.

A powerful pour depressing and good extreme pressure additive for mineral oil lubricants to be used under high temperature conditions consists of a condensation product of a polynuclear aromatic hydrocarbon and a certain

Whiton SOLID STEEL ROTOR

STEAM TURBINES



Available in single stage types up to approximately 1200 HP rating. Center supported frames are available when required.

Turbine shown above is one of 24 ordered to drive centrifugal pumps designed to deliver 100 BHP at 3600 rpm with steam at 850# — 850° F. total temperature exhausting against 42# gauge back pressure.

● SIMPLE DESIGN FOR ACCESSIBILITY

Inlet and exhaust connections are located in lower half of casing which is horizontally split to allow easy access to all internal parts. Rotating unit including bearings and governor head may be removed without disturbing alignment of the unit.

● RUGGED CONSTRUCTION FOR RELIABILITY

Whiton rotors are made from a solid steel forging with semi-circular buckets milled in the rim to give strength where it is needed. End thrust is minimized because the path of the steam is always at right angles to the shaft.

● SAFETY DEVICES FOR TROUBLE-FREE OPERATION

Standard equipment includes Constant Speed Governor with V-Ported Governor Valve . . . Emergency Governor with Independent Valve . . . Steel Plate Steam Strainer . . . Two oil rings per bearing supplemented by water cooling . . . Sentinel Type Casing Relief Valve . . . Additional accessories available as required.

THOUSANDS OF SATISFACTORY INSTALLATIONS SINCE 1911

Write for complete information

Whiton 1856

WHITON MACHINE COMPANY

NEW LONDON, CONN., U.S.A.

also makers of Fine Lathe Chucks • Gear Cutting Machines • High Production Milling Machines • Centering Machines

paraffin wax sulfonyl chloride. The additive has a molecular weight of at least 500.

U.S.P. 2,483,505. Compounded Lubricating Oil. D. T. Rogers and J. G. McNab to Standard Oil Development Company.

A mineral lubricating oil is compounded with 0.02-20 percent of a product obtained by reacting under particular conditions elementary sulfur with a basic polyvalent metal salt of an alkylated phenol sulfide having at least 5 C atoms in each alkyl group. The lubricant is useful as crankcase lubricant for internal combustion engines, and the additive retards deterioration of the oil.

U.S.P. 2,483,571. Reaction of Organic Substances with Phosphorous Sesquisulfide. E. W. Brennan and N. D. Williams to The Pure Oil Company.

Olefinic hydrocarbons with at least 8 C atoms are heated in mixture with P_2S_3 to a temperature of 215-300° F. The heated mixture is aerated with free oxygen-containing gas at a rate to induce an exothermic reaction and maintain a reaction temperature of 240-300° F. without the application of external heat. A sulfurized-phosphorized lubricating oil additive is obtained.

U.S.P. 2,483,800. Grease Composition. J. C. Zimmer and G. W. Duncan to Standard Oil Development Company.

A mineral base lubricating oil is compounded with a complex of a metal salt of oil soluble sulfonic acid and a water soluble salt of an inorganic acid free of chloride ions, at least one cation in these salts being polyvalent. Sufficient amounts of the additive are employed to thicken the oil to grease consistency.

U.S.P. 2,483,859. Antiring-Sticking Lubricating Composition. M. van Loon to Shell Development Company.

A lubricating composition comprises a mineral oil and a dispersed minor amount of a polyvalent metal salt of a reaction product obtained by simultaneously polymerizing and alkylating in the presence of a Friedel-Crafts catalyst a hydroxy aromatic monocarboxylic acid, such as salicylic acid, and an olefin with at least 4 C atoms. The additive inhibits ring sticking by the lubricant decomposition products.

U.S.P. 2,484,146. Lubricating Composition. S. J. Barber and J. T. Eaton to E. F. Houghton & Company.

Mineral oil, or a mixture thereof and a saponifiable oil or metal soap gelling agent, is compounded with 2-25 percent of a phosphoric acid salt of a condensation product of certain alkylene or alkylol amines an dcertain higher fatty acids, which salt is soluble in the mineral oil.

U.S.P. 2,484,728. Wax Separation. I. E. Pattillo to Socony-Vacuum Oil Company, Inc.

A sweatable oil-wax mixture or slack wax is molten. The molten mixture is cooled in a substantially quiescent state, at a rate of at least 1° F. per minute to a temperature at which wax crystals are initially formed (e.g. 80-100° F.). The resulting slurry is immediately filtered at this temperature by passing it through a press under a pressure gradually increasing from atmospheric to about 400 psi. A wax cake of high melting point is obtained.

PETROCHEMICALS

U.S.P. 2,481,583. Condensation of Olefinic Compounds with Hydrogen Sulfide. J. B. Fenn and J. L. Eaton to Sharples Chemicals Inc.

A tert. olefinic hydrocarbon is contacted with H_2S in fluid state in the presence of BF_3 and HF at a temperature below 0° C. Marcaptans are obtained.

U.S.P. 2,481,826. Process for Making Aliphatic Nitriles. J. N. Cosby to Allied Chemical & Dye Corporation.

A gaseous mixture comprising 1 molecular of olefin, 1-10 mols of ammonia ,and oxygen is reacted, preferably in the presence of an oxidation catalyst, e.g. a vanadium catalyst, at a temperature of 400-600° C. Aliphatic nitriles are produced.

U.S.P. 2,482,285. Diolefin-Styrene-Alkenlethenyl-Carbinol Tripolymers. C. J. Mighton to E. I. du Pont de Nemours & Company.

An aqueous emulsion of 60-75 percent of a 1,3-diene hydrocarbon, 5-20 percent of a (1-alkenylethynyl) carbinol with 2-6 C atoms in the alkenyl group, and of styrene forming the remaining portion of the mixture, is polymerized to form a rubber-like material of good tensile strength.

U.S.P. 2,482,438. Acetylene Manufacture. S. P. Robinson to Phillips Petroleum Company.

Details are claimed of a process of preparing acetylene by the cracking of a C_2 or C_3 paraffinic hydrocarbon stream in admixture with steam and further treatment of the ethylene containing effluent gas in the presence of a catalytic body of stainless steel containing at least 7 percent Ni.

U.S.P. 2,483,049. Halogenation Process. J. C. Hillyer and C. H. Ice to Phillips Petroleum Company.

A conjugated diolefin with 4-10 C atoms is dissolved in methylcyclopentane. Bromine is introduced into the solution at a temperature of -60 to +30° C. The rate of introduction is controlled so that the mol ratio of unreacted diolefin to free bromine in the solution is maintained at not less than 1:1. Vicinal dibromide is obtained.

U.S.P. 2,483,566. Catalytic Acylation of Aromatic Compounds. R. B. Thompson to Universal Oil Products Company.

An aromatic hydrocarbon is reacted with an acylating agent in the presence of a non-carboxylic alkane sulfonic acid catalyst. Alkyl aryl ketones are produced.

U.S.P. 2,483,903. Process of Preparing an Addition Product of 1,3-Butadiene and Furfural. G. Herbolsheimer to Phillips Petroleum Company.

One,3-butadiene is reacted with furfural at a temperature of 50-350° F. in the presence of a solid contact-type condensate catalyst, e.g. a silica gel or silica-alumina catalyst. An addition product of the two components is formed which seems to be at least partially copolymeric. It is useful in the preparation of phenolic resins, plasticizers, etc.

U.S.P. 2,483,753. Copolymer Composition. T. S. Carswell and R. F. Hayes to Monsanto Chemical Company.

A mixture of 20-75 parts styrene and 80-25 parts 2,5-dichlorostyrene is copolymerized. The copolymer has a lower degree of inflammability than polystyrene.

U.S.P. 2,484,042. Halogenation of Aliphatic Conjugated Diolefins. P. Mahler to Publickers Industries, Inc.

Aliphatic conjugated diolefins are reacted in the vapor phase with undiluted chlorine or bromine in an amount insufficient for complete saturation of the diolefin at a temperature of 25-100° C. The reaction mixture is quickly passed into water to separate the dihalo monoolefins from unreacted halogen in the form of relatively dense water-immiscible oily globules.

U.S.P. 2,484,268. Allyl Thiophene. P. D. Caesar and D. E. Badertscher to Socony-Vacuum Oil Company, Inc.

Thiophane is condensed with an alcohol (e.g. allyl alcohol) containing an olefinic linkage between 2 aliphatic C atoms, one of which is directly linked by a single bond to the carbinol C atom. About 0.2 mole H_2SO_4 of 50-98 percent conc. per mole of the alcohol is present in the reaction.

U.S.P. 2,484,702. Hydration of Olefins. F. E. Frey to Phillips Petroleum Company.

An olefin is intimately contacted with a solution of 10-70 percent by weight of HF in water. A mol ratio of HF to olefin of 1:1 to 10:1 is maintained in the reaction zone at a temperature of 0-250° C. The aliphatic alcohol corresponding to the olefin employed is recovered.

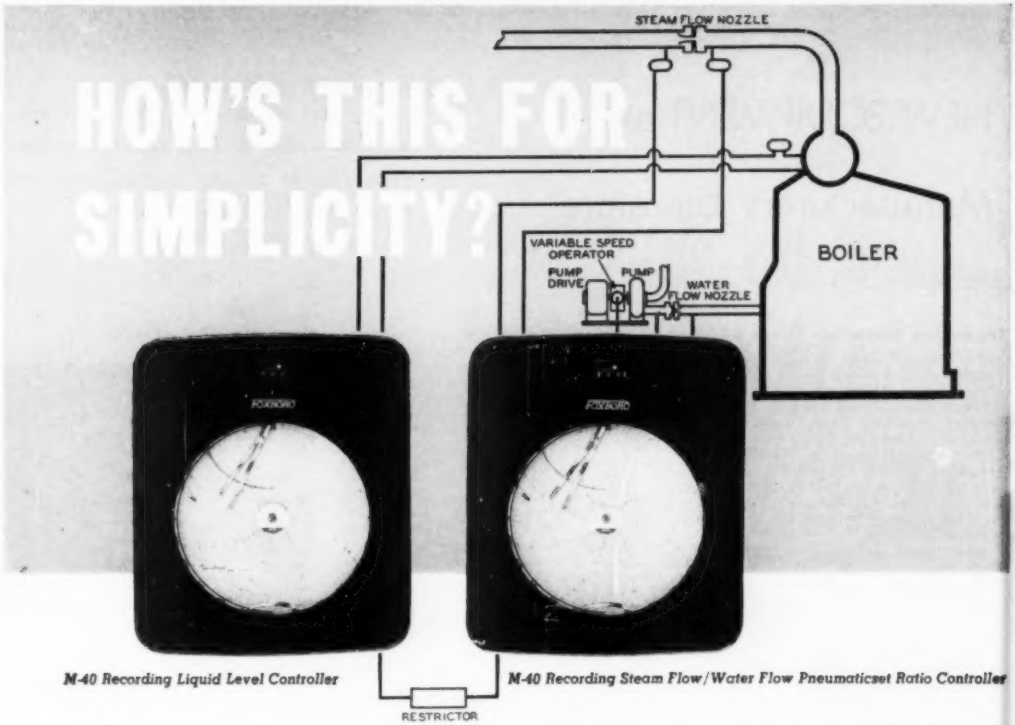
DESULFURIZATION

U.S.P. 2,484,381. Purification of Carbonyl Sulfide Contaminated Hydrocarbon Gases. A. B. Johnson and J. T. Higgins to California Research Corporation.

Hydrocarbon gases, such as propane and propylene, contaminated by CS_2, e.g. from a cracking operation, are mixed with hydrogen and then contacted with a hydroforming catalyst under conditions adapted to hydroform petroleum naphtha. Hydrocarbon gases free of CS_2 are recovered from the reaction effluent.

Magnolia Names Foremen

George D. McClelland has been promoted from an engineering assignment at Magnolia Petroleum Company's general offices in Dallas, to plant foreman of the Chitwood gasoline plant in the Duncan, Okla. district. Charles E. Freeman, recently on an engineering assignment in the construction and maintenance section of the Natural Gas Department, has been promoted to plant foreman of the Sholem-Alechem gasoline plant in the Healdton, Okla. district.



M-40 Recording Liquid Level Controller

M-40 Recording Steam Flow/Water Flow Pneumaticset Ratio Controller

3-Element Control for Boiler Feed Water with ONLY 2 INSTRUMENTS... NO AVERAGING RELAYS

Here's an opportunity to simplify boiler feed water control . . . and make it more dependable too. With this Foxboro system on a boiler of high steaming rate and low drum capacity, you get all the advantages of 3-element control, *plus* ratio-setting automatically adjusted by boiler water level. Ratio setting is undisturbed by the temporary effect of "swell" or "shrink" caused by sudden load changes.

This new standard of simplicity and dependability in boiler feed water control is made possible by two Foxboro Instruments, the M-40 Recording Steam Flow/Water Flow Pneumaticset Ratio Controller and the M-40 Recording Level Controller. The flexibility of Pneumaticset is outstanding . . . making the following combinations available almost instantly: (a) full automatic—steam flow/water flow ratio controlled, with ratio set by level; (b) semi-automatic—steam flow/water flow ratio controlled, with ratio set by hand; (c) remote manual—feed water valve manually positioned from instrument.

Engineering data are available to help you check and compare this system. Write **The Foxboro Company, 74 Neponset Avenue, Foxboro, Mass., U. S. A.**

THESE M-40 FEATURES INSURE UNUSUAL RELIABILITY

1. Unmatched ease and stability of adjustment **2.** Emergency-proofed—instrument can be dismounted without disturbing manual control panel **3.** Self-aligning ball linkage—pinch clip for easy removal **4.** Main and sub-assemblies interchangeable with those of other M-40 Controllers **5.** Precision-built, inside and out **6.** Proportional band setting, 0 to 200, either direct or reverse action made by turn of dial **7.** Wide range variable reset resistance, 0.1 to 50 minutes, without use of needle valves or lengths of capillary tubing

FOXBORO
REG. U. S. PAT. OFF.
RECORDING · CONTROLLING · INDICATING
INSTRUMENTS

NEW EQUIPMENT and Manufacturers' Literature

For copies of manufacturers' literature or more information about products described on these pages write to the address shown, using the number shown for each item desired.

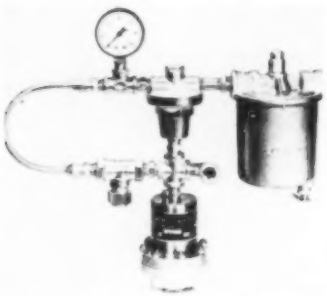
Insulation Materials (Item 646)

A technical data booklet describes Bigelow-Liptak Corporation's new line of products, which includes block insulation, insulating cement, finishing cement, insulating wool, blanket insulation, pipe insulation, boiler wall coating, and protective coating. Complete information on conductivity, heat transfer, and application is contained in tables and charts in the booklet on the block insulation, insulating cement, and blanket insulation.

The block insulation, BL-17, is an all-purpose mineral wool material for temperatures up to 1700° F.; insulating cement, C-18, is an all-purpose mineral wool plastic for temperatures up to 1800° F.; insulating cement, RC-23, is a semi-refractory plastic insulation for temperatures to 2300° F.; finishing cement, C-10, is a hard white finish coating for temperatures to 1000° F.; insulating wool, W-12, is a mineral wool insulating material for temperatures to 12000° F.; blanket insulation, BN-12, is a flat resilient insulating material for temperatures to 1200° F.; pipe insulation, PC-12, is a ready-formed pipe covering for temperatures to 1200° F.; boiler wall coating, BC, is a plastic-type seal for temperatures to 400° F., and protective coating, WP, is a weatherproof seal for insulation surfaces.

For further information write Bigelow-Liptak Corporation, 2842 W. Grand Boulevard, Detroit 2, Michigan, referring to this PETROLEUM REFINER item.

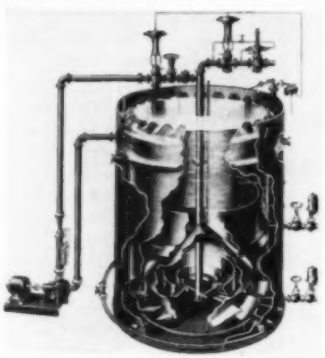
Pneumatic Transmitter (Item 647)



Employing the force balance method with a fixed nozzle system, the new F-C series 5000 penumatic transmitter, developed by Instruments, Inc., meets all requirements for measurement of pressure, vacuum, specific gravity and level, according to the manufacturer. By means of two transmitters, it is possible to measure differential pressure or flow. Since the entire measurement system is dependent on the travel of the diaphragm towards or away from the nozzle, extremely high sensitivity, accuracy and absolute repeatability are obtainable. The isolation of the transmitting air pressure from the measured variable by the diaphragm, eliminates any possible aeration of the material. No open connections prevent the measured material to back into the transmitting system in the event of air failure.

For further information write Instruments, Inc., Tulsa, referring by number to this PETROLEUM REFINER item.

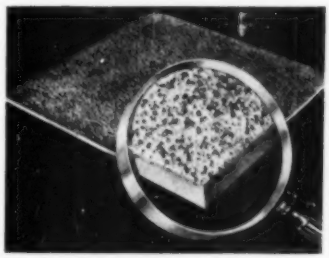
Water Softener (Item 648)



Worthington Pump and Machinery Corporation has announced a new cold process slurry type precipitating water softener and coagulator employing hydraulic energy for mixing the applied chemicals with previously formed precipitate. Thus optimum flocculation is achieved without the use of submerged mechanical moving parts within the softener. Complimentary recirculation of treated water maintains a uniform depth of slurry bed independent of load demand. Where filters are used for final clarification, a washer reclamation compartment is incorporated to enable the filters to be economically backwashed with clean, chemically inert water without imposing increased flow rates thru the softener. Density of the slurry bed is automatically and proportionately maintained.

For a copy of Bulletin W-212-B5 write Worthington Pump and Machinery Corporation, Water Treating Section, Dunellen, N. J., referring by number to this PETROLEUM REFINER item.

Floor Plate (Item 649)



By combining heretofore irreconcilable materials (abrasive grain and rolled steel), Alan Wood Steel Company has developed an abrasive non-skid floor plate which is being marketed under the trade name of "A. W. Algrip." Uses include industrial floors, loading platforms and ramps, walkways, building entrances, and for trench and hatch covers. Abrasive grain, the same type used in grinding wheels, is rolled as an integral part of the upper portion of steel floor plate. It can be sheared, drilled, countersunk, machined and flame-cut. The floor plates are available in thickness from ⅛ to ½ inches inclusive, and in widths up to 60 inches maximum by 144 inches long.

For copies write Alan Wood Steel Company, Conshohocken, Pa., Department W-96, referring by number to this PETROLEUM REFINER item.

Atomizing Valve (Item 650)

For use on deaerating heaters, vacuum deaerators, and hot process softeners, Belco Industrial Equipment Division, Inc., has developed a proportioning type atomizing valve which "insures uniform atomization under all varying load conditions." Available in capacity ranges up to 2000 gpm., the valve is non-clogging and designed to provide a tangential spraying action and atomization of incoming water to droplet form. The valve has an external stem and is diaphragm operated. The diaphragm may be actuated either by a float cage pilot or differential orifice. Balanced inner valve design

What do we mean... DOWELL SERVICE?

Service is something you can't see, smell or touch. You can't pick it up, inspect it, test it and say, "This is good service." No—when you buy service you buy certain intangibles that are your insurance of good performance—good service. What are these intangibles? Knowledge, experience, dependability—those are the things you buy . . . the things that Dowell sells.

Dowell is a *service* organization . . . specialists in the chemical cleaning of boilers, heat exchange equipment, lines and piping, water wells and other types of industrial equipment. A subsidiary of The Dow Chemical Company, Dowell exists only to serve—to bring to industry, through its service organization, the applied benefits of chemical discoveries. All the research at Dowell and at The Dow Chemical Company is good research only if it helps you. Dowell men are trained in that concept—Dowell equipment is designed for that purpose. It's not just the physical doing of another job, but rather the active desire to put the things that research discovers to work serving you. It is this sincere wish to help that has given Dowell the knowledge, experience and dependability that are back of every job.

Perhaps you have a problem Dowell can solve. We'd like to try. Plants in many industries have found it profitable to use Dowell Service for preventive and regular maintenance cleaning. That's Dowell Service—chemistry at work for you. Call Dowell today.

Specialists in the use of chemicals to remove deposits

from steam generators, condensers, heat exchangers, cooling jackets, water wells, water and product lines, gas washers, filters, towers and other industrial equipment.

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DOWELL

A SERVICE ORGANIZATION

The Tanks are Elevated

NOT THE PRICES!

Posey is Equipped to Do the

Complete Job...from (1) Design to (2) Fabrication to (3) Erection

Posey Iron believes that there's no need to elevate prices on elevated tanks. Posey long ago adopted its own inflation resistance program . . . has never raised prices simply to follow the "trend". Instead, Posey engineers bear down to eliminate cost-padding frills and unnecessary steps of construction . . . overlook nothing that will permit estimates that are low *for workmanship of high integrity.*

Posey tanks are welded steel throughout . . . with no rivets where corrosion might gain a foothold. With interior surfaces as smooth and curved as those of a fine ball bearing, Posey Tanks are leak-free . . . corrosion resistant.

Let us know your conditions and we may be able to show you how Posey elevated storage tanks can increase capacity . . . aid production . . . reduce maintenance . . . and perhaps eliminate expensive equipment. Write today. No obligation.

POSEY IRON WORKS, INC.

formerly LANCASTER IRON WORKS, INC.

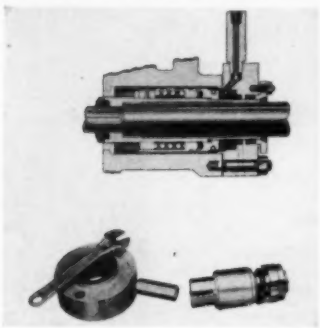
LANCASTER, PA., U.S.A.

TANKS
WROUGHT IRON, STEEL AND ALLOY STEEL PIPE
O. D. PIPE
TEES
ELBOWS
AUTOCLAVES
STEEL PLATE CONSTRUCTION

is claimed to give accurate and sensitive control characteristics, regardless of line pressure.

For further information write Belco Industrial Equipment, Division, Inc., 103 Iowa Avenue, Paterson 3, N. J., referring by number to this PETROLEUM REFINER item.

Mechanical Seals (Item 651)



Byron Jackson Company of Los Angeles is introducing three types of mechanical seals for centrifugal pumps: —Type U, single seal with stationary face of carbon; type L, "a single, inexpensive and low-pressure single seal designed for small pumps handling cold water or bulk station products where temperatures do not exceed 110° F. and pressures do not exceed 50 psi., and type B, an oil-lubricated double seal designed for high pressures and cold service where pumped liquids contain little, if any, lubricating value. It is claimed that the installation of one of these seals saves the cost of special seal oil systems with their pumps, control valves and instruments.

For a copy of the bulletin write Byron Jackson Company, Pump Division, Terminal Annex Box 2017, Los Angeles 54, referring by number to this PETROLEUM REFINER item.

Industrial Phones (Item 652)

The United States Instrument Corporation of Summit, N. J., has announced a new catalog which describes the company's new line of sound powered telephones for industrial and mine use. Approved by the Bureau of Mines for use where explosive atmospheres are present, these stations operate up to 30 miles without batteries or any outside power for either talking or ringing circuits. Each station consists of a hand set mounted on an aluminum case which contains a 1200 cycle magneto generator, a howler unit with connecting horn for signaling, the necessary terminal blocks and, if selective ringing is desired, a rotary selector switch. Common-talking selective-ringing up to 24 stations, or an unlimited number of common-talking common ringing stations, can be used.

For further information write United States Instrument Corporation, 409 Broad Street, Summit, N. J., referring by number to this PETROLEUM REFINER item.

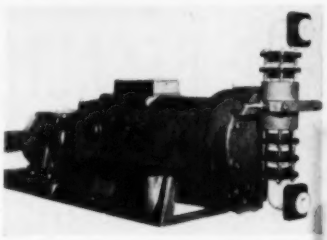
Broaches (Item 653)

For use in forming machine screw size threads, Shearcut Tool Company has produced smaller type thread forming broaches on the standard machine screw sizes. Heretofore, the company manufactured thread-forming broaches to fractional sizes in the U. S. coarse and U. S. fine threads in sizes from ¼ inch diameter upwards. The tool feeds one continuous clip out of the hole.

For further information write Shearcut Tool Company, P. O. Box 746, Reseda, Calif., referring by number to this PETROLEUM REFINER item.

New Equipment

Pumps (Item 654)



By eliminating all metal in parts which can come in contact with fluids being pumped, the "ceramic wet-end" pulsafeeder chemical proportioning pump, developed by the Process Equipment Division of Lapp Insulator Company, Inc., greatly increases the scope of corrosive liquid control. It allows for successful handling of all concentrations of acids, other than hydrogen fluoride, and all metal salts other than strong

FLOWLINE Stainless STEEL
Trade Mark
WELDING FITTINGS
For all Corrosion-Resisting Applications

Smooth, uninterrupted flow is assured in any piping system using *FLOWLINE* stainless steel welding fittings because:

(1) The interior walls of each fitting are free from scores, scratches, die marks, waves, or ridges.
(2) All elbows are "long radius"—1½ times nominal pipe size.
(3) All fittings perfectly match corresponding tubing and pipe sizes in circularity and in wall thickness.
(4) The ends are accurately machine tool cut—fittings of wall thickness over .083" are beveled to 37½° with approximately 1/16" straight face; those with wall thickness of .083" or lighter are cut straight, not beveled.

FLOWLINE fittings are available in Stainless Types 304, 316, and 347—to match pipe and tubing of various wall thicknesses in sizes from ⅜" through 12".

Send for Bulletin S-210

The Most Complete Line of Stainless Steel Welding Fittings
WELDING FITTINGS CORP.
NEW CASTLE, PENNSYLVANIA
Formerly Stainless Alloy Division - Pittsburgh Piping and Equipment Co.
World's Largest Manufacturer of Stainless Steel Welding Fittings

THERMOWELLS

Ground Joint Bar Stock Type

T-120 Series TRINITY Ground Joint Bar Stock Thermowell

T-120 — 1" Ball Type Ground Joint
— 3/8" bore for #14 Gauge Thermocouples
T-121 — 1" Ball Type Ground Joint
— 13/64" bore for #20 Gauge Thermocouples
T-122 — 1¼" Ball Type Ground Joint
— 3/8" bore for #14 Gauge Thermocouples
T-123 — 1¼" Ball Type Ground Joint
— 13/64" bore for #20 Gauge Thermocouples

Sizes: 8", 10", 12", 15", 18" and 24" immersion length. Special orders up to 48" (T-120, T-122 only).

Wall Thickness: 0.187" (T-120, T-122); 0.179" (T-121, T-123).

* * *

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caustics, chlorinated hydrocarbons, halogens and liquids which must be kept sterile or free from metal ion contamination. In this model, reagent-head, valves, and valve housing are armor-encased solid porcelain; gaskets, valve seat, and diaphragm are of inert fluorinated hydrocarbon plastics. Teflon and Kel-F). All standard pulsafeeder sizes are available in the new head construction—capacities up to 330 gallons per hour.

For a copy of Bulletin 295 write Lapp Insulator Company, Inc., Process Equipment Division, LeRoy, N. Y., referring by number to this PETROLEUM REFINER item.

Gate Valves (Item 655)

Design features of bronze gate valves with screwed and flanged ends are described with a large sectional drawing in The Kennedy Valve Manufacturing Company's Circular 102. Service ratings and a comprehensive table of sizes and dimensions are also included. Features include deep-rim mallable iron, non-heating, non-slipping handwheel, and gland-type stuffing box.

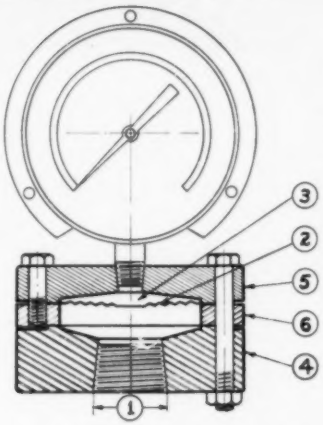
For a copy write The Kennedy Valve Manufacturing Company, Elmira, N. Y., referring by number to this PETROLEUM REFINER item.

Fractionating Tray (Item 656)

The performance of Koch Kaskade trays in distillation, absorption and liquid-liquid extraction is described in Bulletin 525 published by Koch Engineering Company.

For a copy write Koch Engineering Company, 335 West Lewis, Wichita, Kans., referring by number to this PETROLEUM REFINER item.

Diaphragm Seals (Item 657)



Nine types of diaphragm seals are offered by Mansfield & Green for use with any make pressure instrument. This line is intended to assist the increasing use of instruments subject to corrosion or clogging in the chemical and process industry. Cross section of Type A is shown with pressure gage. The unit is pipe mounted (1) exposing the diaphragm (2) to the process pressure. The thin flexible diaphragm transmits the process pressure to the solid liquid fill (3) to operate the bourdon tube of the instrument. The bottom (4) of the cleanout type can be removed for cleaning where the service clogs the space under the diaphragm. Plain type B consists of parts (4) and (5) and does not include part (6). The seals are available in plain type for non-clogging corrosive service or cleanout type for clogging service.

For further information write Mansfield & Green, 1051 Power Avenue, Cleveland 14, Ohio, referring by number to this PETROLEUM REFINER item.

Gas Flow Meter (Item 658)

A new variable-area flowmeter known as the "Floguide" has been developed by Fischer & Porter Company. The tapered precision-bore metering tube and the "float" are fabricated from stainless steel. The metering tube is brazed to the cast iron inlet and outlet fittings, permitting simple and attractive panel installations. The Floguide is available in capacities ranging from 45 to 16,000 standard cubic feet of carbon dioxide per hour, 200 to 76,000 SCFH hydrogen, and comparable capacities for other gases. Although primarily designed for low-pressure service, Floguide meters can be furnished to withstand 600 psig. working pressure in all sizes. Maximum operating temperature is limited by the properties of commercially-available packings.

For further information write Fischer

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BIGGEST STEAM TRAP NEWS in 50 years!

Clark DUO-STEP leverage

Duo-Step Leverage — can save thousands of dollars annually for steam trap users ... in lower initial cost and greater drainage efficiency.

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INCREASES TRAP DRAINAGE CAPACITY OVER 100%

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may mean costly shutdowns. Packing troubles ALWAYS mean higher operating costs. Have you tried Centrifugal Pumps which require NO packing? Most satisfactory for pumping acid and other corrosive liquids.

Descriptive Bulletin on Request

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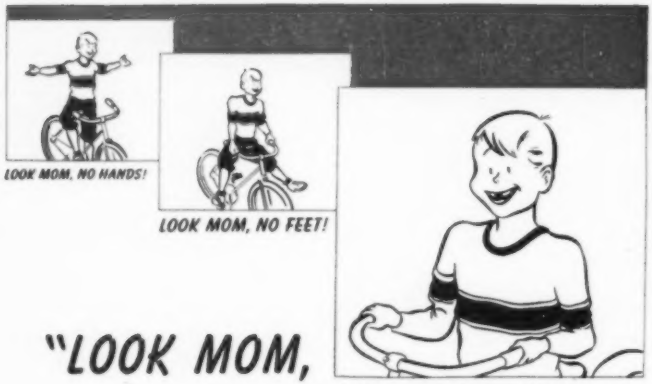

"LOOK MOM, NO TEETH!"

"... *The gages specified on the above order are to replace standard clock gear movement type now in use to indicate pressures in several of our chemical processes which are subject to considerable pulsation.* *From previous experience the writer has found the Helicoid movement to be far superior to the old type.*"

Signed by a Plant Superintendent.
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Of course they have to be dependably accurate—long-lasting—easy to calibrate. Those are the advantages that add up to lower cost per gage, per year. And the more gages you use, the more substantial the saving.

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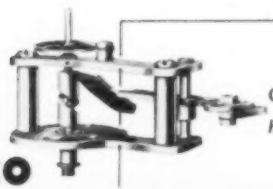


Only Helicoid Pressure Gages have the Helicoid Movement

ACCO

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE
Bridgeport 2, Connecticut

TRADE MARK

New Equipment

& Porter Company, County Line Road, Hatboro, Pa., referring by number to this PETROLEUM REFINER item.

Hard-Water Test (Item 659)

W. H. & L. D. Betz have developed a new simple hardness test for water analysis which is more accurate than the soap method and considerably more rapid. This test is a convenient titration method employing a color indicator. Because of the simplicity of this new method, accurate results can be obtained with non-skilled personnel.

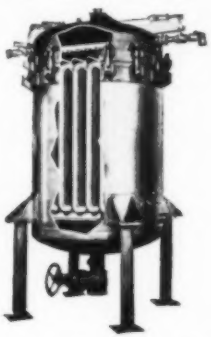
For complete data write W. H. & L. D. Betz, Gillingham & Worth Streets, Philadelphia 24, or Betz Laboratories, Limited, Montreal 1, Canada, referring by number to this PETROLEUM REFINER item.

Mercury Cleaning (Item 660)

A unique method of showing how foul mercury may be made clean and bright has been devised by Bethlehem Apparatus Company, Hellertown, Pa., which is offering demonstration samples. These samples, held within corrugated pasteboard, illustrate "before and after" examples of badly contaminated mercury which has been cleaned in the company's oxifier and type "F" filter.

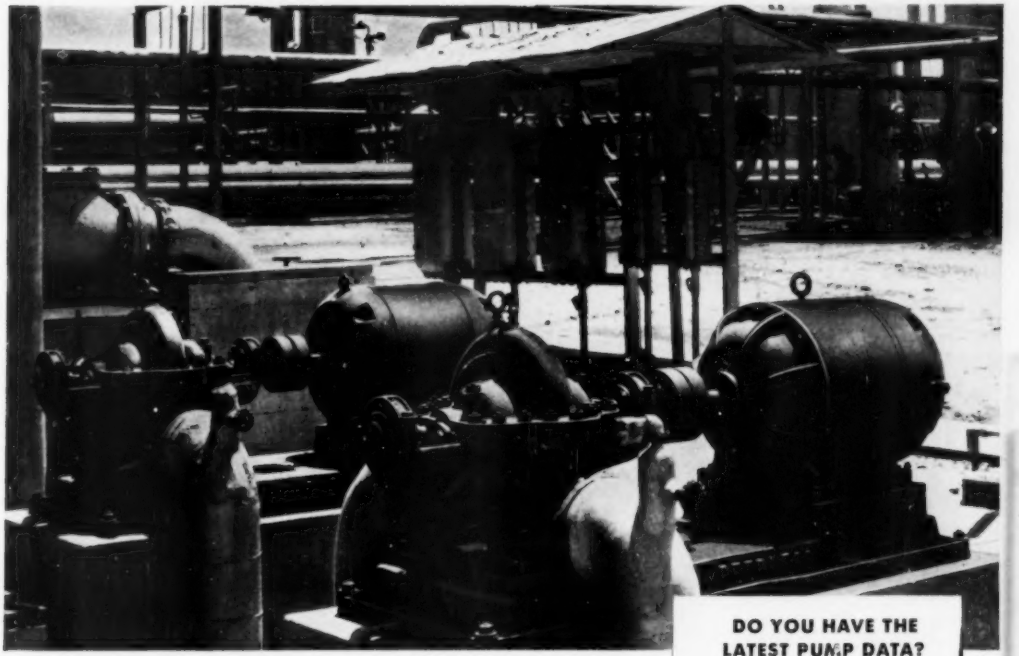
For samples and further information write Bethlehem Apparatus Company, 870 Front Street, Hellertown, Pa., referring by number to this PETROLEUM REFINER item.

Filter Sluicing (Item 661)



Automatic sluicing of filter cake has been developed by Niagara Filter Corporation in its new "Auto-Sluice" filter which permits "completely automatic cake removal and disposal, eleminating the need for opening the filter at the end of each cycle to sluice the cake from the leaves." The "Auto-Sluice" is built into the filter cover and consists of a header into which high-pressure spray nozzles are fitted. These are so positioned that the sprays of sluicing liquid strike the cake of each leaf. Air motors impart both rotary and reciprocating motion, assuring thorough cleaning of all surfaces. The filters are available in sizes from 120 to 500 square feet of filter area and can be built in steel, stainless

WHERE THERE'S A PUMP IN YOUR PLANS



Plan with Peerless Centrifugal Pumps

From plan to plant there's a Peerless horizontal centrifugal pump that meets your needs. For the diversified, continuous duty services of private industries and public projects, Peerless Pumps incorporate many proved advantages in design and construction for extended pump life and operative economy.

All along your flow lines, Peerless can provide pumps incorporating the latest principles of hydraulic practice and experience plus the versatility and efficiency you require for *peerless* pumping performance.

For example, the pumps shown above are single stage, double suction, general purpose Type A pumps, a comprehensive line of Peerless pumps offering a capacity range from 50 to 60,000 gpm. There are scores of other Peerless types, hundreds of other Peerless models for thousands of pumping applications. Peerless furnishes horizontals for handling solids in suspension as well as for clear liquids. There are pumps for boosting, circulating, transferring and filtering. They can handle volatile L-P Gases or tricky acid, basic and salt solutions. They can move liquids at high temperatures or they can provide water (or foam) for *Underwriters' approved* fire protection. Duty can be intermittent or continuous; both single and multi-stage units, with the type of drive you desire, are available, meeting widest head and capacity conditions. Pump and driver are engineered as a unit, tested in a modern hydraulic laboratory that duplicates actual field conditions, to match or exceed purchasers' expectations.

Plan with Peerless for all your needs for pumps. Peerless field and sales engineers are located in all principal cities to help you whenever and wherever there's a pump in your plans. For pump engineering information or service, call on them, or if you prefer, write for the latest pump engineering data. The chart at the right lists a number of the types of Peerless horizontal pump bulletins in which you will be interested.

DO YOU HAVE THE LATEST PUMP DATA?

Informative Engineering Bulletins Available From Peerless Pumps

Here are a few of the services Peerless Pumps perform. Request data by Bulletin number.

Pump Service	Bulletin No.
Water Supply	B-1300
Fire Protection	B-1500
Chemicals and Oils	B-810
Vaporous Liquids	B-2201
Butane-Propane	B-2200
Boiler Feed	B-301
Sewage and Solids	B-154
Hi-Pressure	B-310
Acids and Caustics	D-2400
Process Services	B-803
All-purpose Pumps	B-2301

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FOOD MACHINERY AND CHEMICAL CORPORATION
Los Angeles, California — Indianapolis, Indiana
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Peerless
VERTICAL AND HORIZONTAL
Pumps

steel, various alloys and other commercially available materials of construction.

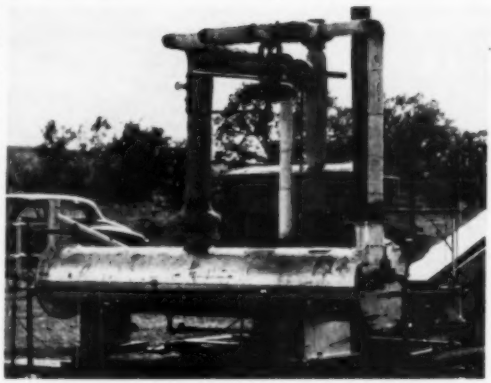
For further information write Niagara Filter Corporation, Buffalo, N. Y., referring by number to this PETROLEUM REFINER item.

Steel Hose (Item 662)

Flexible stainless steel hose is being produced commercially in a highly corrosion-resistant alloy, Carpenter stainless No. 20. Until now, flexible stainless hose has been available only in conventional analyses such as Types 304, 316 and 347. Size range of flexible hose made from Carpenter No. 20 is from about 1" i.d. to 2½" i.d., in various gauges. Because No. 20 provides corrosion resistance in sulfonation and other processes which cause the formation of sulfuric, formic or acetic acids and other highly corrosive agents, the new flexible hose is expected to be particularly useful where full corrosion resistance must be combined with flexibility, on equipment which vibrates or must be moved from time to time. Fittings such as standard pipe size nipples, etc., can be welded to the ends of Carpenter stainless No. 20 flexible hose, or the hose ends can be provided in non-flexible standard tube sizes for use with flanges, etc.

For further information write Alloy Tube Division, The Carpenter Steel Company, Union, N. J., referring by number to this PETROLEUM REFINER item.

Vaporization Unit (Item 663)



To provide fuel for gas engines in regions where natural gas has become scarce or expensive, Black, Sivalls and Bryson, Inc., has developed a simplified and compact unit to vaporize crude oil. The vaporizer is designed to fuel pipe line pumping engines and gas engine equipment on lease pumping jobs where gas is failing. It is equipped with all necessary controls and is insulated to prevent heat loss from the exhaust gas heater and the flash separator, both of which operate at high temperature. Vaporizers are available in sizes of 20, 40, 110 and 300 hp.

For further information write Black, Sivalls and Bryson, Inc., 720 Delaware, Kansas City 6, Mo., referring by number to this PETROLEUM REFINER item.

Indicator (Item 664)

Fairchild Camera & Instrument Corporation's new remote reading ultra high gas temperature indicator, Model 263, "provides a convenient and accurate method for measuring gas temperature to more than 5000° F." The operating principle is based upon well established equations for gas flow through a metering orifice. Proper solution of these equations by the instrument permits obtaining gas temperature to a high degree of accuracy. The range of this instrument is not limited by the thermal properties of available materials. A differential pressure gauge connected across the iridium orifice indicates the temperature of the gases being tested.

For further information write Fairchild Camera & Instrument Corporation, West Coast Division, 53 West Union Street, Pasadena, Calif., referring by number to this PETROLEUM REFINER item.

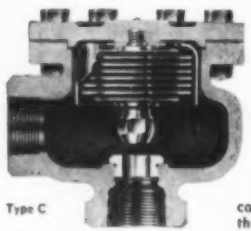
Arc Welding (Item 665)

"Aircomatic," an inert gas-shielded metallic arc welding process for the welding of aluminum has been developed by Air Reduction Sales Company for application to the welding of chrome nickel or stainless steels and aluminum bronzes. The welding process revolves around the continuous feeding of a coiled wire electrode in a gaseous shield through the barrel of a welding gun. High speed continuous deposition of filter metal is possible in all positions with a completely visible arc. When applied to the welding of stainless, the filler metal is carried across the arc and

Nicholson Steam Traps

CUT KETTLE TIME 30%

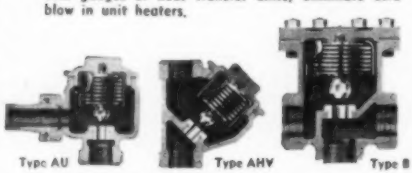
For Leading Processor



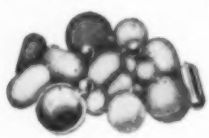
Type C

Records of a recent installation of Nicholson steam traps, by a large processor, show they cut kettle time 30%. For example, one operation was shortened from 65 to 45 minutes. Nicholson units keep equipment full of live steam because: 1) they operate on lowest temperature differential; 2) have 2 to 6 times average drainage capacity. Also record low for steam waste; and maximum air-venting capacity. Widely specified for preventing damage to thin gauges of heat transfer units; eliminate cold blow in unit heaters.

HIGH-PRESSURE FLOATS —Stainless, monel, steel or plated steel. Welded. In all sizes and shapes; for operating mechanisms and as tanks or vessels. 2-day delivery. BULLETIN 348.



Type AU Type AHV Type B



5 TYPES FOR EVERY PURPOSE — process, heat, power; size ¼" to 2"; press. to 225 lbs. BULLETIN 1047.

W. H. NICHOLSON & CO.

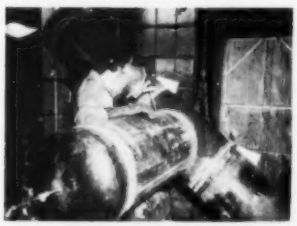
207 Oregon St., Wilkes-Barre, Pa.

TUBE-TURN

tt

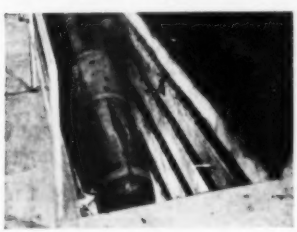
WELDING FITTINGS
AND FLANGES

18-inch standard weight Tube-Turn welding tee and pipe laid out preparatory to assembly for hydrostatic pressure test.

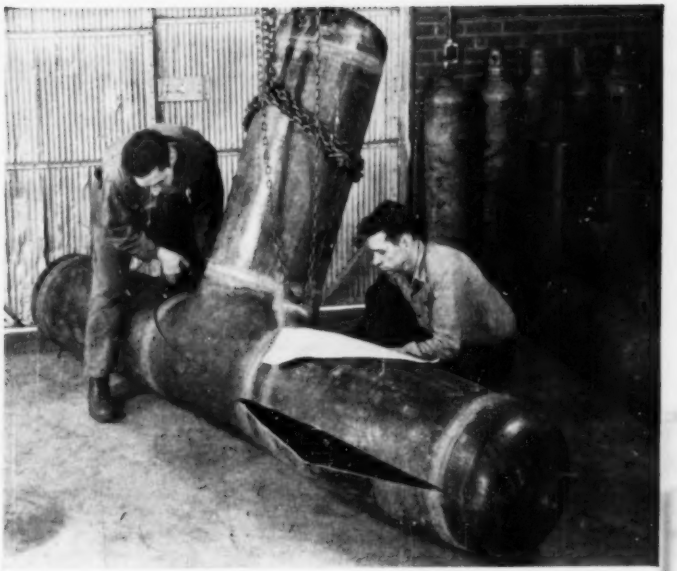


Welder completing last bead in assembly. Fitting and pipe now form homogeneous, leakproof unit.

Assembly is hung in pit, massively lined with concrete. During test top grating is closed and held down by a barricade of sandbags.



Final result after hydrostatic pressure test. The straight pipe burst first, and the tee is undamaged.

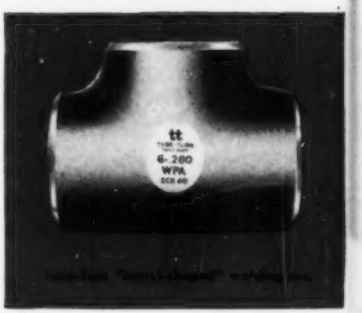


Strength through Design in Tube-Turn welding fittings

The pipe burst first!

Take an 18-inch standard weight welding tee. Take three corresponding lengths of pipe. Weld tee and pipe together. Cap the ends. Lower the assembly into a pit. Then apply hydrostatic pressure—much more than the assembly is supposed to take!

Something has to give! According to the accepted beliefs it should be the tee. But not in the case of the test pictured here. The Tube-Turn "barrel-shaped" tee was used—and the pipe burst, well before the tee was affected! Throughout numerous tests, this new type of tee has withstood at least 25 per cent more pressure than required by the formula given in ASA B16.9.



The superior strength of the tee was achieved without running up extra weight and cost, by carefully planned improvements in shape (based on the sphere, nature's strongest form for internal pressure), and by a carefully engineered distribution of metal.

This is a typical example of *strength through design* in Tube-Turn welding fittings, and another good reason why leading piping engineers specify Tube-Turn equipped, welded piping.

TUBE TURNS, INC.

244 East Broadway, Dept. L, Louisville 1, Kentucky

District Offices at New York, Philadelphia, Pittsburgh, Chicago, Houston, Tulsa, San Francisco, Los Angeles

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Blistering heat! Idling! Overloads! Choking clouds of dirt and dust! It takes high-quality, rugged lubricants to keep modern, heavy-duty gasoline and diesel equipment in good running order. That's why engineers prefer to use Heavy-Duty Lubricants improved with **ENJAY PARAMINS** additives.

Proved PARAMINS mean improved oils and fuels

PARATONE—for improved viscosity index. **PARAFLOW**—for lower stable pour. **PARATAC**—for tacky oils and greases. **PARAPOID**—for E.P. gear oils. **PARANOX**—for oxidation control and detergency. **PARASHEEN**—for better appearance. **PARADYNE**—for improved gasoline.

ENJAY COMPANY, INC.

15 West 51st St., New York 19, N.Y.

PIONEERS IN CHEMICALS FROM PETROLEUM

Additives, Alcohols, Esters, Ketones, Plastics and Oil-Resistant Rubbers

deposited in the weld virtually without loss of alloying elements.

For further information write Air Reduction Sales Company, 60 East 42nd Street, New York 17, referring by number to this PETROLEUM REFINER item.

Handwheel Valve (Item 666)

Eliminating the necessity of the conventional bypass installation, Hammel-Dahl Company's continuously connected handwheel control valve can be manually operated, regardless of maximum instrument air pressure on the diaphragm or in opposition to the spring. The valve comes in 2-inch sizes. The valve plug position indicator automatically indicates the valve plug position, shows the setting of the travel stops, the percent free travel of the valve plug, and in what portion of the valve stroke the free travel can occur. It also shows whether the handwheel is in a neutral position. This handwheel may be applied to any valve, size 1¼ through 16 inches.

For further information write Hammel-Dahl Company, 243 Richmond Street, Providence 3, R. I., referring by number to this PETROLEUM REFINER item.

Computor (Item 667)

An electronic analog computor for quickly and automatically solving the flash vaporization equilibrium equation has been announced by the Special Products Division of Phillips Petroleum Company, Bartlesville, Okla. The computor helps solve such problems as analysis of optimum gas-liquid separator operating conditions, evaluation of gas-condensate reservoirs and gas saturated crude oil fields under conditions of pressure decline, analysis of many fractionation column operations, and estimations of K values. Over-all vapor or liquid fraction calculations may be determined to a probable error of 0.002. Two additional readings on the instrument reduce this probable error to 0.00016.

For further information write Phillips Petroleum Company, Bartlesville, Okla., referring by number to this PETROLEUM REFINER item.

Metering (Item 668)

The Fluidometer system "is an accurate dependable, automatic metering system designed especially for the batching of liquids—either light or heavy. It is adaptable to practically every liquid-measuring problem, whether it involves gallons, barrels, or tank car lots, and is equally accurate on liquids of high or low viscosity." Bulletin FL-9, by Hetherington & Berner, Inc., engineers, and manufacturers of asphalt mixing equipment, contains a full description of this system and a diagrammatic sketch illustrating the principle of operation. The Fluidometer features automatic reset. Operation of the unit is started by a push button, the valve opens automatically starting the flow of liquid through the meter, then the meter in turn drives the control unit by postive, direct drive. The control unit determines the amount of liquid flowing through the system, and when the desired quantity of flow has been obtained, the valve closes automatically.

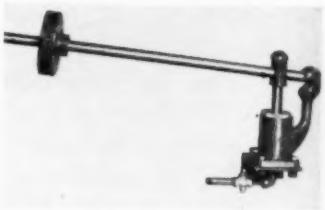
For a copy write Hetherington & Berner, Inc., 701-745 Kentucky Avenue, Indianapolis 7, referring by number to this PETROLEUM REFINER item.

Cumbustion Safeguard (Item 669)

Wheelco Instruments Company has developed the 1300 series Flame-otrol combustion safeguard for industrial and commercial fuel-fired furnaces, ovens, boilers, kilns and other heating equipment. Flame-otrol uses the flame itself as the "electronic link" in a simple electronic circuit to provide instantaneous switching action. It is capable of detecting the presence or absence of a gas or oil flame of any type of burner eliminating the need for costly, specially designed equipment.

For further information write Wheelco Instruments Company, 847 W. Harrison Street, Chicago 7, referring by number to this PETROLEUM REFINER item.

Lubricator (Item 670)



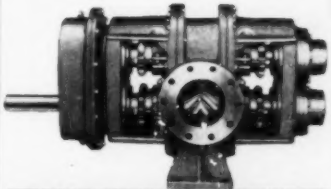
Designed to deliver lubricant at constant pressure in any desired quantity is the new weight-loaded lubricator manufactured by Mixing Equipment Company. The lubricator may be used for greases and oils for stuffing boxes of pumps and mixers, motors and engines, heavy machinery, farm machinery, line shafting bearings, motorized and lubricated valves. Because weights of different valves may be used and adjusted infinitely throughout the length of the lubricator arm, pressures may be applied to lubricants up to 150 psi. The device has a bracket for universal mounting, with a shut-off valve available as optional equipment.

For further information write Mixing Equipment Company, 1024 Garson Avenue, Rochester 9, N. Y., referring by number to this PETROLEUM REFINER item.

Lubricant Tester (Item 671)

Precision Scientific Company, in cooperation with Standard Oil Company of Ohio, has developed the poly-veriform lubricant tester for studying the corrosion characteristics, oxidation stability, and the varnish and sludge formation tendencies of lubricating oils. In contrast to the L4 test, which tests one oil at a time, the poly-veriform tester will evaluate 12 samples. Ten-hour tests on the tester correlate with the ASTM 36-hour L4 Chevrolet Test. The 12-unit aluminum bath is electrically heated and

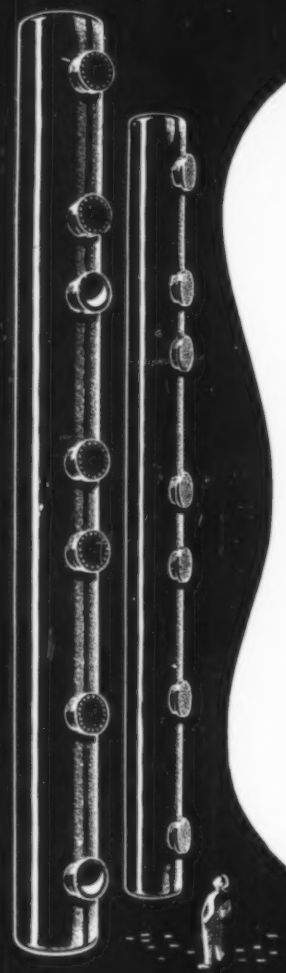
Kinney Heliquad Rotary Pumps are famous for wide-range usefulness and high pumping efficiency. Heavy-duty casings, shafts, thrust and radial bearings, timing gears, and rotors are built to give first-class service year after year. Kinney Heliquad Pumps are available plain or steam jacketed, in capacities to 3000 bbls. per hour. Write for Bulletin L-48; address Kinney Mfg. Co., 3596 Washington St., Boston 30, Mass. Branches in New York, Chicago, Cleveland, Philadelphia, Los Angeles, San Francisco, Seattle, New Orleans, Houston. We also manufacture Vacuum Pumps, Clutches, and Bituminous Distributors.

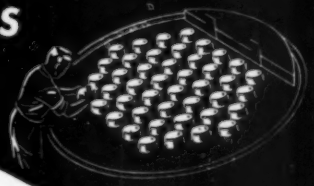


KINNEY Rotary PUMPS

aluminum protects . . .

PETRO-CHEMICAL PROCESSES





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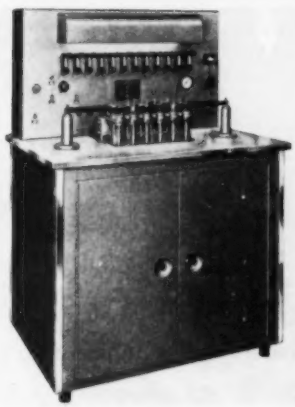


thermostatically controlled. The units can be operated together or in banks of 6 units. Over-all dimensions are 42 inches high, 30 inches deep, 60 inches high.

For further information write Precision Scientific Company, 3737 W. Cortland Street, Chicago 47, referring by number to this PETROLEUM REFINER item.

Handwheel Valve (Item 672)

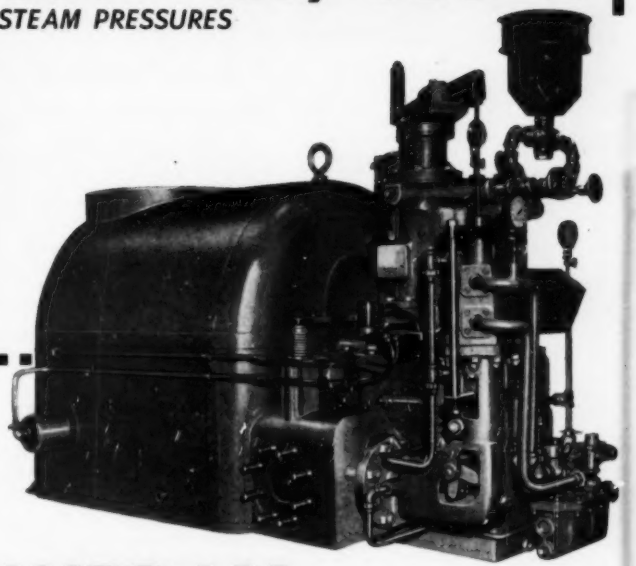
Eliminating the necessity of the conventional bypass installation, is the new Hammel-Dahl Company continuously connected handwheel control valve which may be applied to any valve, size 1¼ through 16 inches. Travel limit stops are incorporated in this design and can be set to limit the valve stroke from 0 to 100 percent. The valve plug position indicator automatically indicates the valve plus position, and shows the setting of the travel stops. It shows at all times the percent free travel of the valve plug, and exactly in what portion of the valve stroke the free travel can occur and also whether the handwheel is in a neutral position. The full clearance window in the all-steel superstructure allows repacking or servicing of the packing box without any disassembly.

For further information write Hammel-Dahl Company, 243 Richmond Street, Providence 3, R. I., referring by number to this PETROLEUM REFINER item.

Shape Cutting Machine (Item 673)

Air Reduction Company's new portable oxyacetylene, shape-cutting machine, the Airco No. 3 monograph weighs 110 pounds and can be stored in a 7 by 1½ foot space. It will cut steel up to eight inches in thickness, in any shape within a 54 by 32 inch area, at speeds ranging from 3 to 30 inches per minute. The length of the cutting area can be ex-

ECONOMY
AT MODERATE INITIAL COST
100 to 4000
HORSE POWER RANGE
600 LB. GA., 750° F.
STEAM PRESSURES



MURRAY
STEAM TURBINES
TYPE UV MULTISTAGE

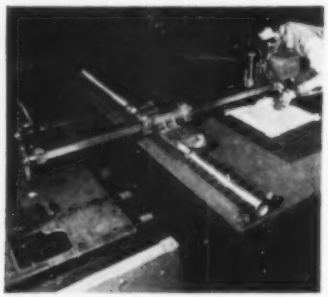
The Type UV Multistage Turbine is available in from two to ten pressure stages making Multistage steam economy available at moderate initial cost. Horsepower range is from 100 to 4000, steam pressures up to 600# ga., 750° F., condensing or non-condensing. Several governors and accessories adapt UV Turbines to practically any mechanical drive within the capacity range.

Pictured is a 5 Stage UV Turbine developing 325 HP at 6200 RPM operating condensing. Turbine is equipped with variable speed oil relay governor, pressure lubrication and vacuum breaker, and is in use driving a centrifugal compressor for refrigeration.

Contact your Murray representative for prices and engineering information or write for Bulletin T-122.

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA
BUILDERS OF STEAM POWER EQUIPMENT FOR THREE QUARTERS OF A CENTURY

New Equipment



tended by adding tubular rail extensions.

For further information write Air Reduction Sales Company, 60 East 42nd Street, New York 17, referring by number to this PETROLEUM REFINER item.

Recorder (Item 674)

A Speedomax recorder which automatically plots the relationship between any two variables, showing one as a function of the other, has been developed by Leeds & Northrup Company. The variables to be plotted are converted d-c signals, and are connected to the instrument, one to the horizontal axis and the other to the vertical axis. The result is a permanent record. The recorder has two measuring circuits. It can automatically draw curves such as a hysteresis loop, temperature vs. temperature difference, stress vs. strain or other two variable curves. The pen takes three seconds for full scale travel of 9⅞ inches. Full chart travel is 10 inches and requires four seconds.

For further information write Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia 44, referring by number to this PETROLEUM REFINER item.

Oil Treating (Item 675)

No. 699H, "Tag Oil Testing Instruments for Petroleum Products," by C. J. Tagliabue Corporation, contains data on the complete line of Tag, Tag-Saybolt, and the Tag-ASTM. instruments for principal laboratory tests of petroleum.

For a copy write C. J. Tagliabue Corporation (New Jersey), 614 Frelinghuysen Avenue, Newark 5, N. J., referring by number this PETROLEUM REFINER item.

Reflectoscope (Item 676)

An ultrasonic instrument which will "instantaneously locate internal defects in metals and other materials by the application of a single searching unit" is the Type UR reflectoscope manufactured by Sperry Products, Inc., and described in Bulletin 50-105. It is claimed to have a 30-foot penetration ability. General applications, principle of operation, and materials that can be tested are also included in the bulletin.

For a copy write Sperry Products, Inc., Danbury, Conn, referring by number to this PETROLEUM REFINER item.

Gate Valves (Item 677)

A new line of 200-pound union bonnet bronze gate valves introduced by The Ohio Injector Company includes 30 items. The new series carries a rated working pressure of 200 pounds steam at 550° F. or 400 pounds water, oil and gas non-shock and are available in the solid wedge non-rising steam design. All have tapered seats and wedges and are recommended for wide open or closed service on lines carrying water, oil, gas and steam. Features include improved body-bonnet ring and pipe-end design, which affords easy installation and repair, along with their metallurgically controlled and processed copper-nickel alloy wedges that give longer trouble-free operation.

For further information write The Ohio Injector Company, Wadsworth, Ohio, referring by number to this PETROLEUM REFINER item.

Sulfur Compounds (Item 678)

The Consolidated Engineering Corporation has developed a new instrument, known as the Model 26-102 Titrilog for the automatic and continuous recording of concentrations of oxidizable sulfur compounds, such as SO_2, H_2S, mercaptans, thioethers, and disulfides in monitoring or control problems on gas streams or atmosphere. Concentrations as low as 0.1 ppm. or 0.005 grains per 100 cubic feet are recorded. The Titrilog operates on the principle of continuously titrating reactive compounds with electrolytically generated bromine to a potentiometric end point. The instrument operates on standard 60-cycle, 115-volt power and requires approximately 6 amps.

For further information write Consolidated Engineering Corporation, 620 N. Lake Avenue, Pasadena 4, referring by number to this PETROLEUM REFINER item.

Gas Odorant (Item 679)

A new, highly-potent gas odorant, "Calodorant 'C'," announced by Oronite Chemical Company, a subsidiary of Standard Oil Company of California, was developed primarily to save handling and servicing costs by gas distributing companies. While the company's presently-used "Calodorant" is added in a proportion of 13 pounds per mcf., this new product is claimed to be equally effective when only one-half is added

Maybe it all *does* look prety much the same at first glance. But when a firm has been making wire mesh for 70 years man and boy, there's bound to be a little more to it than meets the eye —a little more know-how in engineering and weaving, a little more quality in the product, a little more service and satisfaction to the user.

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JELLIFF WIRE MESH is economical. Every foot runs true to the specifications.

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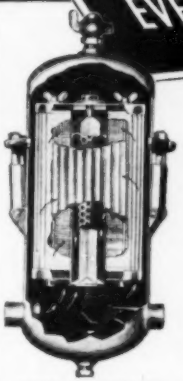
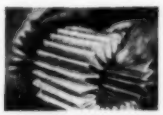


MODEL ELS FILTER
(Sectional View)

• Provides unusual efficiency and economy. *Permits use of any medium that comes in sheet form and can be crimped.* Both first cost and maintenance cost low. Radial Finned Insert provides large filtering area in small space.



NEW SLIP-ON INSERT
FOR QUICK CHANGE OF MEDIUM

Complete Data on Request

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Here are 32 pages of maintenance-cleaning procedures simplified with Oakite materials and methods—all in the new Oakite booklet. Get a copy for data on such maintenance jobs as:

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HOW AQUA-VACTORS PRODUCE VACUUM WITH WATER

CR Aqua-Vactor Uses Water as Motivating Fluid

Combining the advantages of the steam jet ejector and the low cost of water, the Croll-Reynolds AQUA-VACTOR is employed economically in many instances. Low in first cost and with no moving parts, the water jet may be used to mix liquids, serve both as an ejector and condenser, and in isolated cases, handle air and gases.

While not as efficient as a steam jet ejector, the AQUA-VACTOR becomes economical when the pressure of water is being dissipated for other process work. In such cases it may be possible to use the AQUA-VACTOR either as an ejector alone or as both an ejector and a condenser using water under pressure to operate the AQUA-VACTOR and using the exhaust from the AQUA-VACTOR for other processes.

The illustration shows a type SW EVACTOR using steam in the first stage and water in the second stage. Here the AQUA-VACTOR is used both as an ejector and as a condenser, handling air and, at the same time, condensing steam from the first stage. Of interest to engineers with corrosion problems, the steam stage in the illustration is constructed of carbon including the steam nozzle. The carbon is incased in cast iron giving the equipment the strength of iron and the corrosion resistance of carbon.

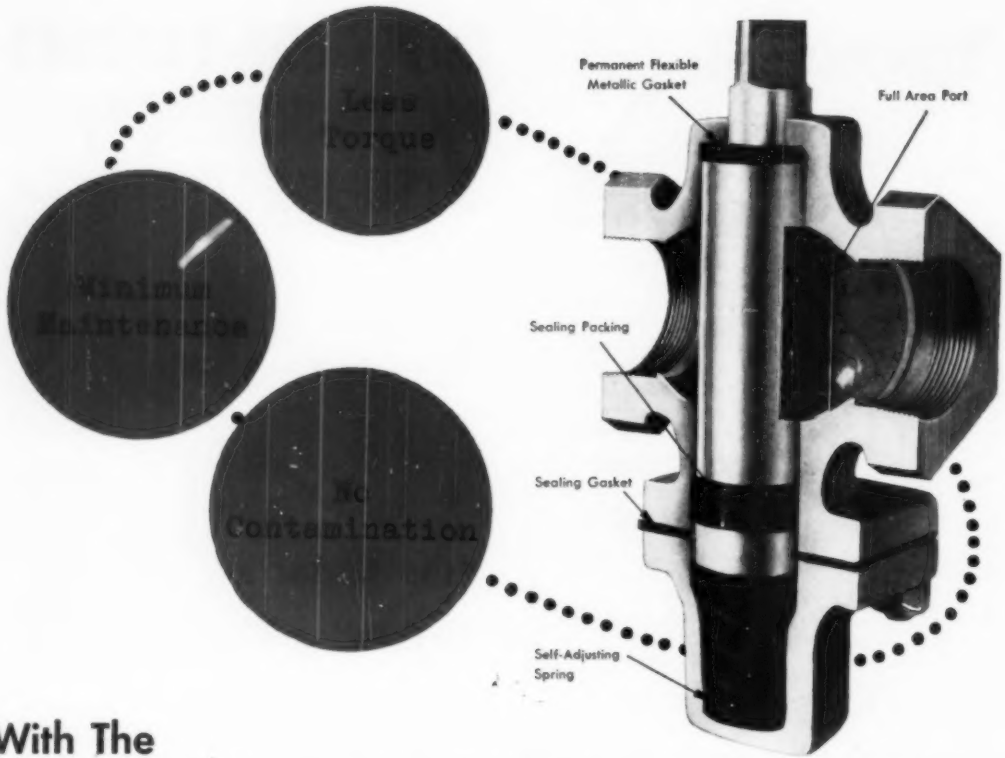
For more complete information concerning the application of the AQUA-VACTOR, or any type of steam jet EVACTOR, write today to:

CROLL-REYNOLDS

CROLL-REYNOLDS CO., INC.

17 John Street

NEW YORK 7, N. Y.



With The
BELFIELD CYLINDRICAL PLUG VALVE

Here's the only non-lubricated valve with a parallel side. The Belfield Cylindrical Plug Valve utilizes a flexible metallic gasket for permanent sealing . . . lubrication is not necessary . . . parallel sides reduce torque to ¼ of tapered plug valves.

The result! The easily turned stem never freezes . . . leakage is no problem . . . there are no lubricants to contaminate the flowing medium . . . and maintenance is practically nil!

In addition, the Belfield Cylindrical Plug Valve can be equipped with electric or air motor for remote control . . . and the port can be designed to provide specified flow characteristics.

Call in your local Honeywell engineer for complete information . . . or write for a copy of Specification Sheet 402!

BELFIELD — WORLD'S LARGEST ORGANIZATION FOR ADVANCED INSTRUMENTATION AND CONTROL — VALVES

MINNEAPOLIS-HONEYWELL REGULATOR CO.
BELFIELD VALVE DIVISION
Philadelphia 44, Pa.
Offices in 73 principal cities of the United States, Canada and throughout the world

MINNEAPOLIS Honeywell — *Diaphragm Valves* AND PROCESS CONTROL SPECIALTIES — Belfield VALVES

to the same volume of gas. "The odor of this compound, instantly detectable, is not nauseous, and is unrelated to any other odors."

For further information write Oronite Chemical Company, 38 Sansome Street, San Francisco, referring by number to this PETROLEUM REFINER item.

Barrel Tool (Item 680)

A new barrel and drum tool for upending, designed with a special tension clinching feature for positive safety, has been announced by D. S. Campbell Company. This handling tool, called E-Z Up is 42 inches long, has no moving parts to slip or break, and weighs six pounds. Specially designed v-shaped strap-iron saddles are located at the point of leverage and the point of lifting. The leverage saddle at the end of the tool laps over the top expanded rolling hoop, while the lifting saddle fits tightly to the drum head at two points under the rim which supports the lifting weight. As leverage is applied, pressure forces the saddles to spread and grip the drum surfaces to prevent slipping or rolling.

For further information write D. S. Campbell Company, 6110 Euclid Avenue, Cleveland 3, Ohio, referring by number to this PETROLEUM REFINER item.

Water Conditioning (Item 681)

Bulletin No. 610 entitled "Elgin Water Conditioning," issued by Elgin Softener Corporation gives information on the design and application of water conditioning equipment including zeolite water softeners, water treating chemicals, water conditioning systems for boilers and processing, water softener modernization, zeolites, water filters, taste and odor removers and aerators.

For a copy write Elgin Softener Corporation, Elgin, Ill., referring by number to this PETROLEUM REFINER item.

Ring Wrenches (Item 682)

To make valve maintenance easier, two new steel seat ring wrenches have been developed by The Lunkenheimer Company. Both are heat-treated alloy steel for maximum strength and wear. The union bonnet ring of the valve acts as a guide, bearing against a shoulder on the wrench, assuring firm engagement with the seat ring being removed or put in place. Described in Circular No. 579, one wrench has a threaded collar which provides for adjustment on different depth valves. It is available in sizes to fit valves from ¼ to 3 inches. The other wrench is of one piece construction and is designed for "A. A. R." plug type valves from ¼ to 2 inches inclusive.

For a copy write The Lunkenheimer Company, Beekman and Waverly Avenues, Cincinnati 14, referring by number to this PETROLEUM REFINER item.

Uniclosed Motor (Item 683)

A uniclosed horizontal motor, having horsepower ratings from ¼ to 250, is described in Bulletin 1524 of U. S. Electrical Motors, Inc. Features include armorclad asbestos-protected windings, drip-proof housing, Lubriflush lubrication, normalized castings, cyclone ventilation, centricast rotor, and annealed laminations. Discussions of temperature rise in motors and its effect upon windings is also discussed.

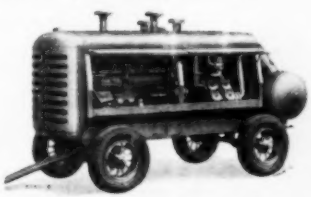
For a copy write U. S. Electrical Motors, Inc., 200 East Slauson Avenue, Los Angeles 54, referring by number to this PETROLEUM REFINER item.

Vibration Control (Item 684)

Bulletin ER-701 of Korfund Company, Inc. describes a cork and mounting material used to control transmission of vibration and noise. Photographs, sketches and graphs accompany the data explaining resiliency, the damping factor, sound insulation, and methods of installation. With a recommended loading range of 750 to 5000 pounds per square foot, the "elasto-rib" requires no bolting or cementing. Three types of dampers have a loading range from less than 40 pounds per unit to more than 1250 pounds. Material is available in specially ordered sizes and shapes or sheets 24 by 36 inches.

For a copy write Korfund Company, Inc. 48-43-G, Thirty-Second Place, Long Island City 1, N. Y., referring by number to this PETROLEUM REFINER item.

Air Compressor (Item 685)



For portable compressor users who prefer full diesel-engine drive, a new 1KA 500-cfm. mobil-air compressor has been developed by Ingersoll-Rand Company. The instrument has all the features used on the company's KA series mobil-air compressors in sizes from 105-to-500-cfm. Other features include two-stage air-cooled compressor, hydro-shift flex-disc clutch, channel valves, and running gear and mountings. A choice of three engines is included. Full 500-cfm.

AMMONIA
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DIRECT SERVICE
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TANK CARS
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Discuss contract
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SPENCER CHEMICAL COMPANY
Executive & Sales Offices: Dwight Bldg., Kansas City 6, Mo.

capacity is delivered at rated 100-psi. pressure.

For further information write Ingersoll-Rand Company, New York 4, referring by number to this PETROLEUM REFINER item.

Portable Ventilators (Item 686)

A portable ventilator, developed by Mine Safety Appliances Company and described in Bulletin CU-2 is equipped with high-velocity fans powered either by gasoline or electricity. The portable ventilators provide both ventilating and cooling air. Air is conveyed to the desired point through a 14-inch-diameter, 16-foot-long canvas duct. Ducts are treated for flame and mildew resistance, and when not in use can be collapsed and folded into a compact bundle. A two-way air flow feature permits the duct to be connected to either the inlet or discharge side of the fan, allowing both dust or noxious gases to be withdrawn and fresh ventilating and cooling air supplied.

For a copy write Mine Safety Appliances Company, Braddock, Thomas and Meade Streets, Pittsburgh 8, referring by number to this PETROLEUM REFINER item.

Metal Hose (Item 687)

Metal hose, developed by Pennsylvania Flexible Metallic Tubing Company, is "capable of withstanding pressures up to 350 pounds." Flanges to go with the hose, were designed to handle highly volatile liquids and still be leakproof. Known as Penflex Titepak, these flanges are claimed to be lighter than other types on the market.

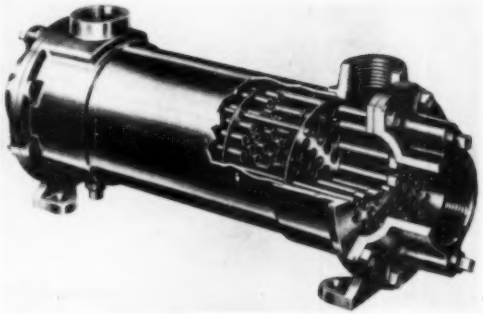
For further information write Pennsylvania Flexible Metallic Tubing Company, 7205 Powers Lane, Philadelphia, referring by number to this PETROLEUM REFINER item.

Monochromator (Item 688)

The "first true universal monochromator, which covers the ultraviolet, visible, and infrared regions of the spectrum (18 microns to 40 microns) when suitable prisms or gratings are used," is offered by The Perkin-Elmer Corporation. Designated as the Model 83 monochromator, it consists essentially of the company's present Model 12 infrared spectrometer optics from entrance slit to exit slit, with the wavelength and slit controls under a standard cover but on a new base assembly. The optics are totally reflecting so that the instrument can be focused with visible light for use in ultraviolet or infrared as well.

For further information write The Perkin-Elmer Corporation, Glenbrook, Conn., referring by number to this PETROLEUM REFINER item.

Heat Exchanger (Item 689)



"The first all-stainless steel heat exchanger to reach mass production," is announced by Ross Heater & Manufacturing Company, Inc., Bulletin No. 17K1 describes the new series designated as type SSCF. Identical in design and capacities to the well known type BCF exchangers which are all-copper and copper alloys, the new model, type SSCF, utilizes stainless steel to avoid contamination of fluids or corrosion by fluids. The series is offered in a complete range of sizes tested to 450 psi.

For a copy write Ross Heater & Manufacturing Company, Inc., 1407-1411 West Avenue, Buffalo 13, N. Y., referring by number to this PETROLEUM REFINER item.

Compressors (Item 690)

Pedestal type centrifugal compressors and expansion turbines are described in a Clark Brothers Company, Inc. bulletin. A cross-section is contained in the bulletin which explains design features of the compressor, including high pressure floating oil seal, bearing pedestal, rotor, bearings, lubricating system, compressor drive, and control. Expansion turbine loading for electrical generator and electric brakes is also explained with multistage centrifugal compressors and acial flow compressors.

For a copy write Clark Brothers Company, Inc., Olean, N. Y., referring by number to this PETROLEUM REFINER item.

Industrial Safety (Item 691)

Willson Products, Inc's. industrial safety equipment catalog, in addition to providing information on the company's line of eye and respiratory equipment, contains a fund of technical and reference material to help the user select the proper type and style of equipment for the specific occupational hazard involved, and to give him information on its use and care.

For a copy of the catalog write Willson Products, Inc., Reading, Pa., referring by number to this PETROLEUM REFINER item.

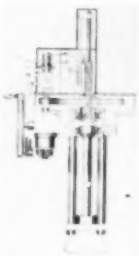
Fire Extinguishers (Item 692)

A fire extinguisher catalog offered by Ansul Chemical Company illustrates the company's complete line and includes improved Model B extinguishers, piped systems, large stationary units, fire trucks, trailers, etc. The catalog also features charts showing characteristics of approved hand fire equipment and comparative effectiveness graphs.

For a copy write Ansul Chemical Company, Marinette, Wis., referring by number to this PETROLEUM REFINER item.

Throttling Control (Item 693)

A pneumatic power operator for throttling control service is the Rotomotor, developed by Conoflow Corporation for use with valves, dampers and other control devices. The operator is the only one employing a reversible pneumatic motor and gear driven screw stem. It combines the features of a self-locking stem, continuously connected handwheel, and compact size. Bulletin No. C-20 lists nine other features, gives a cross-section diagram of the operator, ordering information, and describes applications to butterfly, paper stock, Saunders, and high-pressure angle valves.



For a copy write Conoflow Corporation, 2100 Arch Street, Philadelphia 3, referring by number to this PETROLEUM REFINER item.

Suction Pumps (Item 694)

VMT pumps, designed for handling liquids, hot or cold, corrosive or non-corrosive, where the net positive suction head is limited, are described in Bulletin No. 49-6600 of Bryon Jackson Company. Also included are general assembly and construction details with standard specifications and outline dimensions. Depicted are typical installations for pipe lines, power plants, and refineries.

For a copy write Bryon Jackson Company, Pump Division, Terminal Annex, Box 2017, Los Angeles 54, referring by number to this PETROLEUM REFINER item.

Strainer (Item 695)

Strong, Carlisle & Hammond Company has added a new, high quality, low-cost strainer, primarily designed for the protection of steam traps, reducing valves, and temperature controls. This strainer is recommended for removing impurities such as lint, scale, dirt or

FISHER TYPE 430

BLENDING VALVE

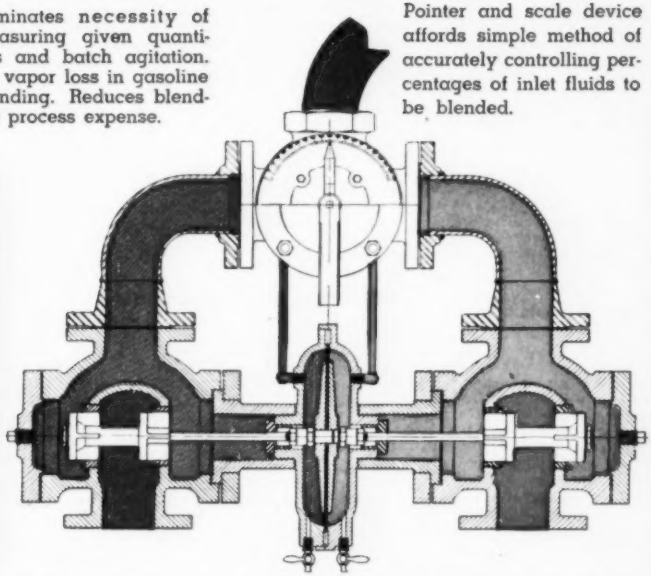
Automatically Blends Two Fluids in Accurate, Desired Proportion

Eliminates necessity of measuring given quantities and batch agitation. No vapor loss in gasoline blending. Reduces blending process expense.

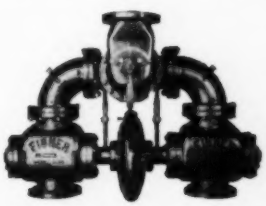
Pointer and scale device affords simple method of accurately controlling percentages of inlet fluids to be blended.

LEGEND

- FLUID A Fluctuating Inlet Pressure
- FLUID A Constant Equalized Reduced Pressure
- FLUID B Fluctuating Inlet Pressure
- FLUID B Constant Equalized Reduced Pressure
- FLUID C Blended Fluid of Desired Characteristics



The Fisher Type 430 Blending Valve is particularly designed to automatically —and with accuracy—control blending processes common to the petroleum industry. Fluids from two different storage tanks are accurately blended even though pump or inlet pressures vary. Liquids to be blended are brought to the pressure equalizing valves, which maintain equal pressure at both inlets of the proportioning valve. This valve controls flow of the two liquids in definite proportion as indicated by the scale.



CAPACITIES: 30 to 900 G.P.M.
SIZES: 3″ and 6″ Only
PRESSURE RATING: 3″, 100 lbs. per sq. in.
6″, 150 lbs. per sq. in.

Write today for complete specifications and prices

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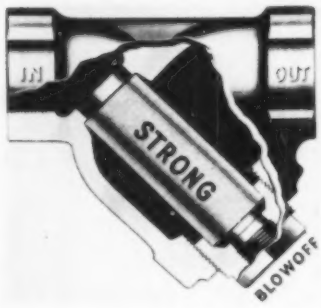
MARSHALLTOWN, IOWA

New Equipment



sand from steam, air, water or gas. Sizes range from ¼ to 2 inches for steam pressures to 250 psi, or cold pressures to 400 psi. Special features include monel screen; an "extra heavy semi-steel body" with self-centering screen guides to prevent crushing; a screen removable for cleaning; and new gripping lugs on inlet and outlet bosses which permit installation with any type of wrench.

For further information write Strong, Carlisle & Hammond Company, Cleveland, Ohio, referring by number to this PETROLEUM REFINER item.

Refractory Ware (Item 696)

"Leco Zircon Refractory Ware," a catalog of Laboratory Equipment Corporation, describes Leco combustion tubes, stock size tubes, combustion tube liners, thimbles, boats and shields, ignition ware in low and high temperature, melting and brazing crucibles, refractory plate, hearth plates, flame ring and collar, triangles, conical heating core and perforated discs.

For a copy of the catalog write Laboratory Equipment Corporation, St. Joseph, Mich., referring by number to this PETROLEUM REFINER item.

Control Devices (Item 697)

Designed to assist in locating uncommon equipment related to industrial automatic control, Bulletin No. 103 of Conoflow Corporation gives specifications and engineering data on principal items in the company's line. Included are springs, diaphragm and springless Conomotors; eight types of control valves; combination regulator-filter, manual loading, instrument supply and differential regulators; pressure transmitters, thrustmeters; and manual control panels.

For a copy write Conoflow Corporation, 2100 Arch Street, Philadelphia 3, referring by number to this PETROLEUM REFINER item.

Fabricated Equipment (Item 698)

A Brown-Hutchinson Iron Works folder describes 24 types of engineered equipment for heat treating; pickling; chemical plants, and pulp and paper mills.

For a copy write Brown-Hutchinson Iron Works, 1831 Clay Street, Detroit 11, referring by number to this PETROLEUM REFINER item.

Exhausters (Item 699)

Roots-Connersville Blower Corporation, Connersville, Ind., has issued a revised booklet 120-B-14 which covers the company's line of centrifugal blowers and exhausters. The company's experience in designing centrifugal units is reviewed with discussions on various centrifugal advantages and operating characteristics of R-C units. Design and construction features of single stage and multi-stage units are given as are inert gas generators, positive displacement meters, and cycloidal vacuum pumps with briefly outlined applications.

For a copy write Roots-Connersville Blower Corporation, 900 West Mount Street, Connersville, Ind., referring by number to this PETROLEUM REFINER item.

Equipment Cleaning (Item 700)

Six pamphlets describing latest, improved procedures that contribute to economical handling of equipment-cleaning operations in the petroleum industry have been published by Oakite Products, Inc. Operations featured are cleaning and descaling heat exchangers, cleaning and paint stripping storage tanks, cleaning tank car interiors, salvage cleaning, chemical-circulation cleaning of absorption, stablizing and fractionating towers, and drum washing and reconditioning.

For copies write Oakite Products, Inc., 150B Thames Street, New York 6, referring by number to this PETROLEUM REFINER item.

Self-Priming Pump (Item 701)

The Model 40 series R self priming Durcopump of The Duriron Company, Inc., now in regular production after two years of experiment and plant and field testing, is claimed to prime in 22 seconds with a static lift of 15 feet, cutting priming time by 66⅔ percent. Plant tests of the pump conducted in accordance with Hydraulic Institute standards have shown that after being primed, the pumps maintain dry vacuum as high as 28.4 inches of mercury. The pump is available in two sizes, one with capacity ranging from 20 gpm. against 81 feet tdh. to 160 gpm. against 33 feet tdh. and the other capacity ranging from 40 gpm. against 125 feet tdh. to 240 gpm. against 75 feet tdh. when operating at 1750 rpm.

For a copy of Bulletin 816 write The Duriron Company, Inc., 17 East 42nd Street, New York 17, referring by number to this PETROLEUM REFINER item.

Instrument Valves (Item 702)

Edward Valves, Inc., Bulletin No. 491, provides information on new drop forged steel instrument valves for meter, gage, instrument, and other small lines. These new valves have a rating of 6000 pounds water, oil or gas at 100° F. or 1500 pounds standard pressure at 850° F. with carbon steel bodies and 1500 pounds sp. at 1000 F° with stainless steel bodies. Included are dimensions, weights, prices, and operating date.

For a copy write Edward Valves, Inc., East Chicago, Ind., referring by number to this PETROLEUM REFINER item.

Alloy Castings (Item 703)

The Duraloy Company has developed high alloy castings in chrome-iron, chrome-nickel, and nickel-chrome. Corrosion-resisting, heat-resisting, and centrifugal castings are described in Bulletin 3049. Seven types of castings, including chrome-iron and chrome-nickel are explained in tabulation form which gives general and specific applications, oxidation resistance, corrosion resistance, strength at high temperature, machinability and welding.

For a copy write The Duraloy Company, 12 East 41st Street, New York 17, referring by number to this PETROLEUM REFINER item.

Liquid H2 Container (Item 704)

An unusual container for the storage and transport of liquid hydrogen and liquid helium (Hofman Laboratories, Inc.) is made of three concentric copper spheres. The inner and outer spheres form a conventional vacuum flask, with facing interior surfaces polished to a mirror-like finish. Between them is placed a third sphere, highly polished on both sides, which acts as a radiation shield. This shield is attached by a unique connection to the inner sphere of a smaller side flask for containing liquid nitrogen. The containers are available in 10, 25, and 50 liter capacities with side flasks holding 5, 15, and 25 liters respectively.

For further information write Hofman Laboratories, Inc., 212 Wright Street, Newark 5, N. J. referring by number to this PETROLEUM REFINER item.

Boiler-Tube Welding (Item 705)

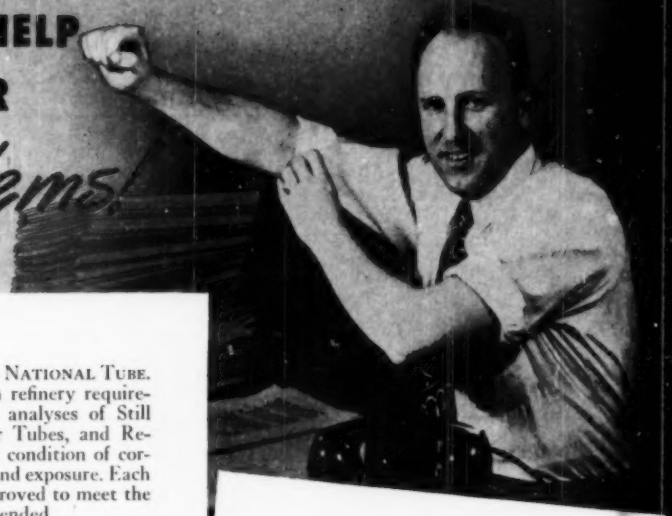
A new process for welding boiler tubes, "which effects a large saving in time," has been developed by Combustion Engineering-Superheater, Inc. The principles of induction heating and pressure welding are both employed in the new process which is used to make tube joints. A high-frequency generator supplies power for the induction coil, the heating from which serves in effecting a pressure-type weld. A feature is an enclosed atmosphere to protect the welding surfaces against oxidation during the heating period.

For further information write Combustion Engineering-Superheater, Inc., 200 Madison Avenue, New York 16, referring by number to this PETROLEUM REFINER item.

Centrifugal Pumps (Item 706)

Goulds Pumps, Inc. is offering a new line of stainless steel centrifugal pumps designed for handling corrosive liquids in the process and other industries. Bulletin 725.3 describes various features of the pumps such as a stuffing box under suction pressure only, piping connections

WE'RE READY TO HELP YOU LICK YOUR *Tubing Problems!*



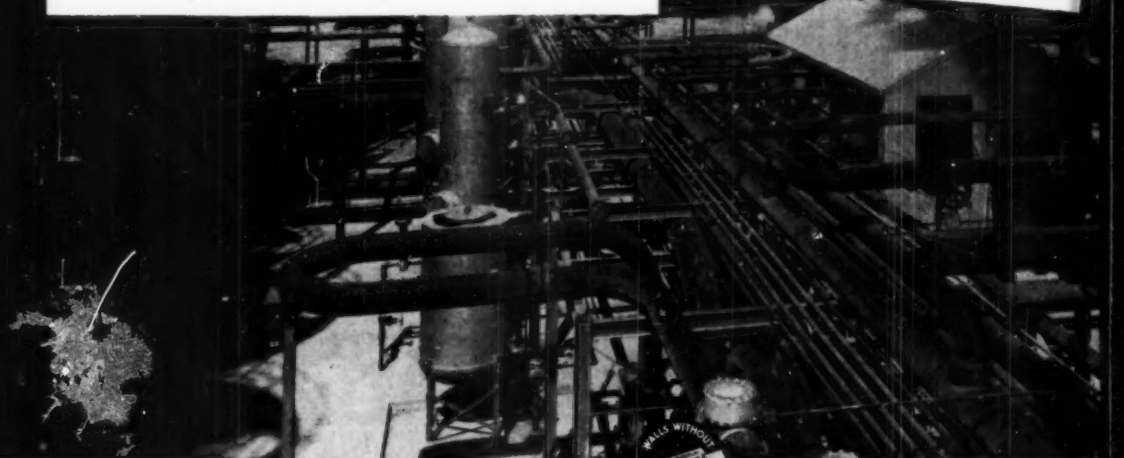
BRING your refinery piping problems to NATIONAL TUBE. As a result of long experience with refinery requirements, we have available 28 different analyses of Still Tubes, Condenser and Heat Exchanger Tubes, and Refinery Piping covering practically every condition of corrosion, oxidation, temperature, pressure and exposure. Each of these 28 different analyses has been proved to meet the specific condition for which it is recommended.

Yes, come to Tubing Headquarters. Tell us what conditions are at your plant . . . and what you expect of the pipe and tubing you buy. We'll check the information you provide against our large and ever-growing file of past problems involving similar conditions which have been successfully solved with NATIONAL Seamless Pipe and Tubes. The chances are we'll come up with a recommendation that will exactly meet your requirements . . . and save you a lot of time, trouble, and money! At any rate, it will cost you nothing to find out just what we can do for you!

NATIONAL TUBE COMPANY, PITTSBURGH, PA.
(Tubing Specialties Division)
COLUMBIA STEEL COMPANY, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

28 DIFFERENT ANALYSES

- Low Carbon
- Low Carbon, ½ Moly.
- Low Carbon, 1 Moly.
- ½ Cr., ½ Moly.
- 1 Cr., ½ Moly.
- 1¼ Cr., ½ Moly.
- 2 Cr., ½ Moly.
- 2 Cr., ½ Moly., 1¼ Sil.
- 2¼ Cr., 1 Moly.
- 2½ Cr., ½ Moly., ¾ Sil.
- 3-Cr., ½ Moly., 1¼ Sil.
- 3-Cr., 1 Moly.
- 5-Cr., ½ Moly.
- 5-Cr., ½ Moly., 1½ Sil.
- 5 Cr., ½ Moly., Titanium
- 7 Cr., ½ Moly.
- 8 Cr., ½ Moly.
- 8 Cr., 1 Moly.
- 9 Cr., ½ Moly.
- 9 Cr., 1 Moly.
- 12 Cr., Aluminum
- 17 Cr.
- 27 Cr.
- 18-8
- 18-8 Titanium
- 18-8 Columbium
- 18-8 Molybdenum
- 25-20



USS

NATIONAL SEAMLESS PIPE AND TUBES

UNITED STATES STEEL

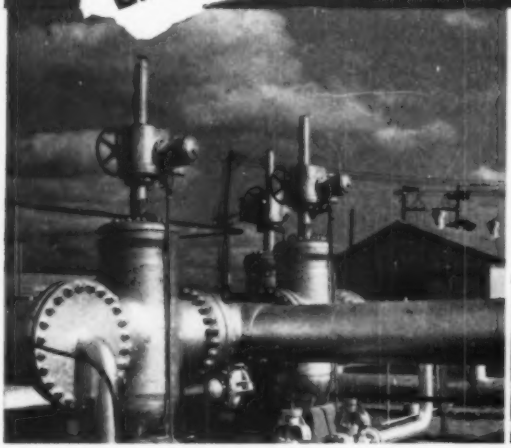
another tribute to "LIMITORQUE"

...BASIN-OZARK PIPE LINES

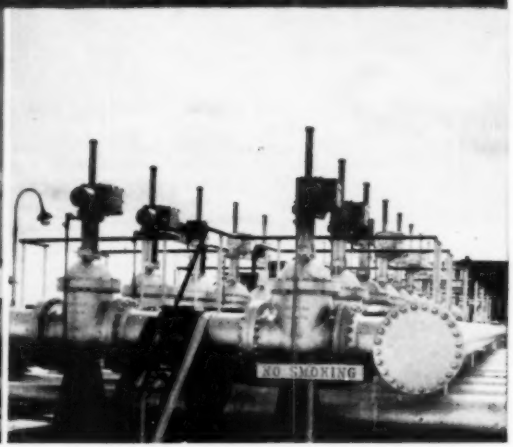
USE MORE THAN

200 LIMITORQUE

MOTOR-OPERATED VALVE CONTROLS



Showing 3 (of many) "LimiTorque" Motor Operated Valve Controls installed on "W-K-M" Valves . . . for remote control on pipe line manifold, crude oil line.



Showing 18 (of many) "LimiTorque" Motor Operated Valve Controls installed on "Darling" Valves . . . for remote control on pipe line manifold, crude oil line.

The "Basin-Ozark" Pipe System consists of a total of about 950 miles of 20", 22", 24" diameter pipe—running from Wichita Falls, Texas, to Wood River, Illinois, and is one of the largest lines ever built by private capital. Through the Texas Pipe Line Co., Shell Pipe Line Corp. and the Empire Pipeline Co., we were privileged to supply over 200 "LIMITORQUE" Motor Operated Valve Controls.

"LIMITORQUE," as the name implies, *limits the torque applied to the operating parts* (due to an exclusive, patented "torque switch")—and thus prevents damage to discs, stems, seats, etc. Further, "LIMITORQUE" Valve Operators permit local or remote push-button control; save time, labor and money; close valves at exact speed required, and are absolutely dependable and safe . . . and they utilize any power source: electricity, oil, gas, water or air.

Thousands upon thousands of "LIMITORQUES" are used throughout the world in Oil Pipe Lines, Refineries, Central Stations, Power Plants, Water and Sewerage Plants, Gas Companies, Chemical and Process Plants, and on Shipboard.

Note: The valves on which the above mentioned "LIMITORQUES" are installed were manufactured by Darling Valve & Manufacturing Co. and W. K. M. Company.

Our 96-page catalog shows different types; how they work; how they are connected; wiring diagrams; control panels; floor stands; position indicators; installation views; views of "LIMITORQUES" applied to most all makes of valves—indeed, a veritable "treatise" on Motorized Valve Operation.

Please be sure to use your business letterhead when writing for this valuable catalog.

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Industrial Gears and Speed Reducers
LimiTorque Valve Controls

in casing and adjustment for wear. A list of materials of construction and a chart of parts interchangeability are offered. Performance curves, and specifications and dimensions of all main parts are also given.

For a copy write Goulds Pumps, Inc., Seneca Falls, N. Y., referring by number to this PETROLEUM REFINER item.

Shock Absorber (Item 707)

R-S Products Corporation's catalog introduces a new line of 50-pound narrow face-to-face valves, designed particularly for rugged hydraulic service. Also shown are the stuffing boxes, which include plain, lubricated, lubricated with purge connections and the rotary seal. Another bulletin features four models of a compact shock absorber which eliminate shock and hammering in pipe lines carrying water or petroleum products. Description, applications, installation, instructions and list prices are included.

For copies write R-S Products Corporation, Wayne Junction, Philadelphia 44, referring by number to this PETROLEUM REFINER item.

Pipe Marker (Item 708)

Self-adhesive "Quik-label" pipe marker for identifying small-diameter pipe and conduit from ¼ to 2 inches in diameter is described in Bulletin 144 of W. H. Brady Company. The markers conform to ASA Standard A13, "Identification of Piping Systems." Each marker comes mounted on its own card, making it handy for carrying in tool kits and pockets. Each card is equipped with its own starter-strip which automatically releases part of the label for fast application.

For copies, write W. H. Brady Company, 815 North Third Street, Department 156, Milwaukee 3, Wis., referring by number to this PETROLEUM REFINER item.

Calcium Carbide (Item 709)

National Carbide Corporation's "The Miracle of Calcium Carbide" traces the history of calcium carbide from the time of its discovery as a commercial possibility, through the developments of manufacture and the current and potential usage of commercial calcium carbide, acetylene gas, and calcium hydrate residue. Also discussed are the potential uses of calcium carbide as an industrial chemical reagent and of by-product calcium hydrate as a source of high calcium lime.

For a copy write National Carbide Corporation, Room 1656, 60 East 42nd Street, New York 17, referring by number to this PETROLEUM REFINER item.

Corrosion Resistance (Item 710)

U. S. Stoneware Company's corrosion-resistant materials and equipment are described in Bulletin M and include tygon tubing, lining materials, grinding and mixing equipment, chemical stoneware, white chemical porcelain, corrosion-resistant masonry and tower packing. Formulations and standard sizes are given in table form and each type of material or piece of equipment is accompanied with a picture.

For a copy write U. S. Stoneware Company, Akron 9, Ohio, referring by number to this PETROLEUM REFINER item.

BOOKS of Interest

Infrared Molecule Analysis Discussed in New Book

"Infrared Determination of Organic Structures" by J. R. Dangl, R. G. Fowler, Nelson Fuson and H. M. Randall, gives background information and outlines methods of approach in infrared analysis predicting of the molecular structure of chemical compounds, with particular emphasis on organic chemistry rather than molecular physics. The authors have explored possibilities of the infrared method and have itemized currently established correlations between structure and absorption spectrum. Illustrations are offered of the "modus operandi" for proceeding from the measured absorption spectrum to its interpretation in terms of molecular structure.

Other chapters discuss the application of infrared spectroscopy to chemical analysis; interpretation of specific structure groups and methods for recognition of these groups; application of the infrared method in practice; and instruments and experimental techniques. Also included is a catalogue of empirical structural assignments for the double-bond region; a structural assignment catalogue for theoretically analyzed molecules; and spectra of 372 various compounds, which are presented as halftones of the original records for reference value as a library.

D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York; 228 Bloor Street, Toronto, and Macmillan & Company, Ltd., St. Martin's Street, London, W. C. 2, price $10.

Heat Exchanger Standards

For information on the design, manufacture, specification, purchase, operation or maintenance of tubular exchangers, the 1949 edition of "Standards of Tubular Exchanger Manufacturers Association," has been published by the association, a group of eleven manufacturers of shell and tube sheet exchangers.

The comprehensive, illustrated volume covers fabrication and performance; mechanical standards for petroleum refineries, commercial and general process applications; material specifications; fouling factors, temperature and temperature differences; heat transfer and pressure drop data; thermal properties of fluid; installation, operation and maintenance and characteristics of tubing.

Sulfur in Petroleum

Four tables listing values for the various physical properties of those sulfur compounds most likely to occur in petroleum and petroleum products are given in "Sulfur in Petroleum, Part III. Selected Physical Properties of Some Sulfur Compounds," a report on Investigations 4566 by R. Vernon Helm, William E. Haines, and John S. Ball. This report represents the result of work done under a cooperative agreement between the Bureau of Mines, United States Department of the Interior, and the University of Wyoming.

Also included in the report are nomenclature of sulfur compounds, a description of the Bureau of Mines research program on sulfur in petroleum, methods of selection of values of properties, and tables of physical properties.

Table I, on revised and additional data, including boiling points, refractive indices, densities, and freezing points. Tables II, III, and IV contain refractive indices for the F, C, and G lines of hydrogen and the helium D_3 line; surface tensions and viscosities; and refractivity intercepts, specific dispensions, specific refractions, and parachors.

For a copy write Superintendent of Documents, Bureau of Mines, Washington, D. C.

Petroleum Bibliography

An up-to-date bibliography of available information on investment and operating costs for processes in general use in the petroleum refining and chemical industries has been released by the Bureau of Mines. The publication was prepared as part of the bureau's oil-shale research and development program and represents the results of work done by the bureau under a cooperative agreement with University of Wyoming.

Designed to assist plant managers in estimating equipment and operating costs of specific petroleum refining and chemical processes, the comprehensive 53-page reference work provides a convenient index to scientific information appearing in trade and professional magazines over the past 18 years. Including an alphabetical listing of nearly all of the equipment and processes currently employed in the petroleum refining and chemical industries, the bibliography also presents brief abstracts of the publications cited in the index. The compilation was prepared by W. I. Barnet, Bureau chemical engineer of the Petroleum and Oil-Shale Experiment Station at Laramie, Wyo.

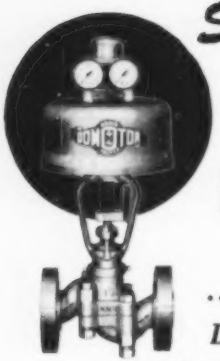
For a copy of Information Circular 7516, "Bibliography of Investment and Operating Costs for Chemical and Petroleum Plants" write Publications Distribution Section, Bureau of Mines, 4800 Forbes St., Pittsburgh 13.

Warren Baker Elected

Warren L. Baker, editor of World Oil, Houston, Texas, was elected 1950 president of the Association of Petroleum Writers at the second annual meeting of the association held in Chicago, November 8. Baker succeeds Paul Hedrick, oil editor of the Tulsa Daily World. Milburn Petty, Petty's Oil Letter, Washington, D. C., was elected vice president and Paul Wollstadt, Platt's Oilgram, was elected secretary-treasurer.

E. G. Seubert Dead

Edward G. Seubert, 73, president of Standard Oil Company (Indiana) from 1927 to 1944, died November 17 in Chicago, following a heart attack. His service with the company, which began in 1891, was the longest of any other employe in the company's history.



Simple V

Stable V

Powerful V

...describes the *Domotor Assembly* of Annin Domotor Valves

The field proven, Domotor Assembly is as simple as it is effective. It is the natural solution to efficient single seated valve operation. Many years of service in hundreds of installations have proved the dependability of the "O" ring sealed cylinder and piston combination—the basic motive element for the Annin Domotor Valve. Since there are no springs to compress in the Domotor Assembly, the entire effect of supply pressure is available for accurate and positive positioning of the single seated valve. This powerful, lightweight construction supplies increased operating forces, and at the same time provides a factor of stability not available in conventional diaphragm motors.

Maximum operating forces from the piston may be obtained in either direction or equally divided by simple adjustment of the loading regulator. The smooth acting positive positioner unit, an integral part of the Domotor Assembly and completely housed within the dome, assures positioning accuracy to within .001 inch anywhere in the piston stroke.

The Domotor Assembly requires no external adjustments. There are no links or levers to invite tampering, get out of adjustment, rust or corrode. This small, compact and easily assembled power unit minimizes problems of transportation, installation and maintenance.

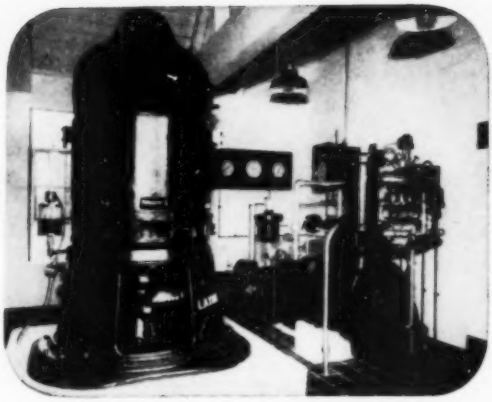
The Domotor housing, piston plate and bottom plate are manufactured from an aircraft-type heat treated aluminum alloy. The cylinder surface is honed to a mirror-like finish, to within 5 micro inches. The entire unit is double Anodized for positive corrosion protection. The piston assembly floats on three "O" ring seals so that there is no metal-to-metal contact during operation. The "O" rings are paraffin impregnated during molding to insure life-time lubrication and eliminate any possibility of sticking.

Write today for this bulletin.

A new bulletin showing installation and operating features of the Domotor Valve will be sent to you upon request.

THE ANNIN COMPANY
3500 Union Pacific Avenue
Los Angeles 23, California

Investigate ANNIN DOMOTOR VALVES *Valves*



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Layne's methods of building well water systems come from nearly three-quarters of a century of world-wide experience. Layne is acknowledged to have the "know how" that omits guess work, disappointment in needed volume and patch ups in construction errors by the less experienced. Layne systems, size for size, are built to, and actually do produce more water than can be obtained by the conventional type of installation.

It is good business to make high efficiency a yardstick in buying a well water system. It is good to know that from Layne you automatically obtain the high efficiency that continually keeps your water production and upkeep at rock bottom cost. In choosing a Layne system you are following the preference of thousands of cities and industries in all parts of the world.

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About EQUIPMENT and SERVICE Suppliers

Two District Sales Managers Named by American Brake Shoe

William C. Bruton has been appointed district sales manager for American Manganese Steel Division of American Brake Shoe Company, and Robert H. Elem has been appointed Pacific Coast manager, at Los Angeles, of the welding products department.

Bruton, formerly sales engineer, first joined American Brake Shoe Company in 1916. His territory covers the Pacific northwest including the Yukon territory and Alaska, and he will make his headquarters at the division's plant in Oakland, Calif.

Elem, a graduate of the University of Southern California, is a former welding engineer. He is a member of the American Society for Metals and the American Welding Society.

Bethlehem Supply Manager

Formerly Bethlehem Supply Company's district manager at San Francisco, J. R. B. Freeman has been promoted to general manager of stores, with headquarters in Los Angeles. Frank T. Merkel, sales engineer in the San Francisco office since 1940, succeeds Freeman as district manager.

Freeman is a graduate of Stanford University, and has been manager of San Francisco operations since 1947, having been promoted at that time from the position of sales engineer at Los Angeles.

Badger Vice Presidents

R. D. Waterman has been named executive vice president of E. B. Badger & Sons Company, Boston. Three other vice presidents of the company, a subsidiary of Stone & Webster, Incorporated, have also been elected: A. J. Broggini, vice president and sales manager, in charge of foreign and domestic engineering, drafting, estimating and sales; A. J. Connell, vice president and engineering manager, in charge of all procurement, and A. J. Good, vice president in charge of office management, contracts and engineering and construction cost analysis.

Waterman has been associated with the company since 1939 in charge of all construction activities, prior to which he was with Stone & Webster Engineering Corporation for 25 years.

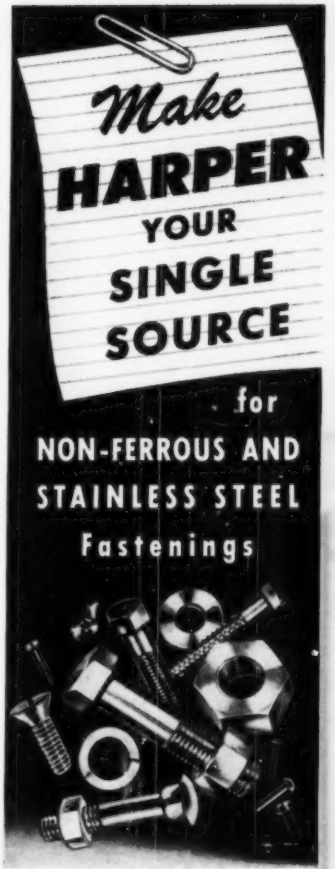
Oliver United Sales Changes

C. W. Crumb, formerly manager of the company's Chicago office, has been appointed sales analyst for Oliver United Filters, Inc. He will work with R. Gor-

ESCH-CONDIT PERSONNEL—New sales offices of Esch-Condit, Inc., were recently opened in Tulsa, El Paso and Beaumont, Texas. Heading the Tulsa headquarters is Frank L. Mill, formerly with Gulf Engineering Company, Inc., Houston. In charge at Beaumont is Robert L. Hearn, Jr., previously employed with E. I. du Pont de Nemours. George Kruitlek supervises the West Texas and El Paso area.

Photograph, above, taken at a recent meeting in the Houston headquarters are, left to right, first row, Frank M. Esch, president, Houston; Miss Emma Holub, secretary, Houston; Jack C. Walker, Houston; Frank L. Mill, Tulsa; Miss Freda Cleland, temporary secretary, Houston; and Paul A. Condit, vice president, Houston. Second row, George Krutilek, El Paso; Arnold E. Bruns, warehouseman, Houston; Jim W. Muster, accountant, Houston; Robert L. Hearn, Beaumont; David G. Founds, Houston; and Joe D. Kebelman, office engineer, Houston.

Esch-Condit, Inc., representations include the following national companies: Air-Maze Corporation; The Annin Company, Valve & Primer Corporation, The Chartomatic Company, Clapp Instrument Company, Honan-Crane Corporation, Kiene Diesel Accessories Inc., Manzel Inc., Meriam Instruments Company, Palmer Thermometers Inc., Panellit Inc., and Trinity Equipment Corporation.



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Only HARPER carries large stocks of **6,000 DIFFERENT ITEMS** in from **3 to 10 DIFFERENT METALS!**—the widest assortment of bolts, nuts, screws, washers, rivets and accessories **available from ONE SOURCE.**

Convenient Warehouse Service for prompt delivery to any point in the country.

Wire or phone your requirements to the nearest Branch Office. Complete 134-page color catalog sent upon request.

THE H. M. HARPER COMPANY
General Offices and Plant: Morton Grove, Illinois
(Suburb of Chicago)

New York Office and Warehouse: 200 Hudson Street, New York 13; **Los Angeles Office and Warehouse:** 835 E. 31st Street, Los Angeles 11. **Branch Offices:** Atlanta, Cambridge, Cincinnati, Cleveland, Dallas, Denver, Detroit, Grand Rapids, Milwaukee, Oakland, Philadelphia, Pittsburgh, St. Louis, Seattle, Toronto (Canada).

HARPER

EVERLASTING FASTENINGS

don Walker on an intensive study of all markets in the United States. Glen G. Reed, who for some time has worked out of the Chicago office, will take over the duties as manager of sales in that territory.

General Controls Announces Three New Branch Offices

General Controls Company, Glendale, Calif., has opened new factory branch office facilities in Minneapolis, Buffalo and Baltimore. Named as branch managers are R. Roger Rosell, Jr., Minneapolis; Paul A. Palmgren, Buffalo, and Fred H. Angier, Baltimore. All are graduate engineers with experience in the field of automatic controls.

The company now has factory branch offices in 21 major cities.

Roller Joins Republic Supply

John S. Roller has joined Republic Supply Company as general manager of sales. He formerly was assistant sales manager of the Birmingham district for Republic Steel Corporation. A native of Youngstown, Ohio, Roller served as a lieutenant-colonel in the U. S. Army in World War II.

Roller

Don L. Collins, formerly executive vice president and general manager of sales will continue his duties as executive vice president for Republic Supply Company which has its headquarters in Houston, and serves the oil and gas industries with supplies at 50 points in ten states.

Lawyer Named Director

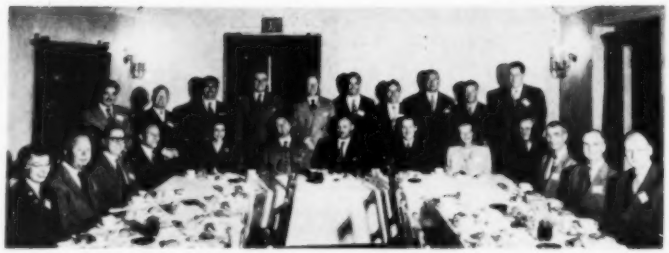
T. L. Harrison, partner of the law firm of Hardy, Stancliffe & Hardy, has been elected a director of Shippers' Car Line Corporation, a subsidiary of American Car and Foundry Company.

QUICK REPAIRS ON
CONDENSERS
and
HEAT EXCHANGERS

If you need condenser or heat exchanger repairs *in a hurry* call us. We specialize in fast, high quality work.

25 Years Successful Experience

GULF ENGINEERING CO., INC.
Service Not Promises
1502 INGEBORG ST. HOUSTON, TEXAS
916 S. PETERS STREET NEW ORLEANS, LA.



WORLD-WIDE MEETING—Filtrol Corporation's first international meeting, brought together the above operative heads and export representatives of the company's international distributing organization from headquarters in the British Isles, Belgium Colombia, Venezuela, Denmark, Holland, Mexico, New Zeland, and the Philippine Islands for a first hand view of the company's new Vernon plant, claimed to be the largest natural catalyst, adsorbent, and desiccant manufacturing unit in the world. The group also reviewed the latest technological improvements in the oil refining industry and discussed the latest American methods in fatty oil refining. Application of desiccants (drying agents) in packaging was also explained along with the company's new coated seed development which, it is claimed, helps reduce agricultural costs and increases commercial growth yield.

Petroleum Refiner Author Is Briner Paint Executive

Briner Paint Manufacturing Company of Corpus Christi has been incorporated with James M. Hammock appointed vice president of sales and John W. Nee, vice president and technical director. The company was founded in 1939 and has been known as the Briner-MacLaren Paint Manufacturing Company until 1941 when George A. Briner became sole owner.

Hammock has been with Kuhn Paint Company of Houston since 1941 except for three years in the Navy. Nee, a PETROLEUM REFINER author, recently resigned as technical director of the Napko Paint & Varnish Works, Houston, to join Briner. A graduate of New York University and Pratt Institute, Nee has spent 21 years in the protective coating industry, nine of which were with Valentine & Company as chief chemist varnish division, and later as chemist in charge of the metal decorating laboratory of Roxalin Flexible Finishes, Elizabeth, N. J.

Phillips Chemical Names Three Sales Managers

Phillips Chemical Company has appointed Amos W. Oakleaf sales manager in charge of foreign and domestic sales of furnace blacks, Philblack A and Philblack O; Raymond J. Hull, manager of Philblack export sales with offices in New York, and George E. Popp, manager of domestic and Canadian sales of Philblack.

Oakleaf, a 1926 graduate from the University of Kansas, (B.A. in chemistry), joined the company in 1944. His headquarters will be at Akron, Ohio. Hull graduated from Purdue University in 1927 with a degree in chemical engineering. Before joining Phillips Chemical Company he was manager of a tire and tube plant in Holland. Popp also held important positions in the tire industry before his association with the company in 1945. He will continue to have his headquarters in Akron, Ohio.

Reintjes Names Agents

Charles T. Snow has been appointed representative of Geo. P. Reintjes Company, Kansas City, Mo., in the sale of the company's arches and walls and will cover Louisiana, lower Mississippi, south Alabama and Florida.

The company has also appointed Interstate Sales, Inc., St. Louis, to represent them in the St. Louis area. Frank Weyforth, president of Interstate Sales, Inc., has had experience in the sale of refractories in this area, especially in the steel mills, oil refineries and industrial power plants.

Lunkenheimer Names Executive

The Lunkenheimer Company, Cincinnati, has appointed Paul M. Arnall vice president and general manager. This action resulted from a decision to divide the functions of president and general manager into two posts, in order to provide for a better distribution of the top management administrative responsibility.

Arnall

After January 3, the company's management organization will consist of Frank P. Rhame, president; Paul M. Arnall, vice president and general manager; Harry A. Burdorf, vice president of Sales; Edmund P. Lunken, vice president; Chester C. Isekeit, treasurer; and Charles W. Burrage, secretary.

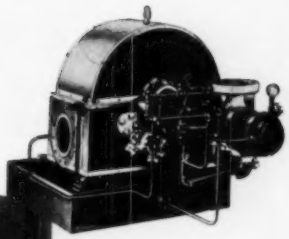
Arnall was educated at the University of Kansas and has had wide experience in the industrial field.

Eutectic's Flushing Plant

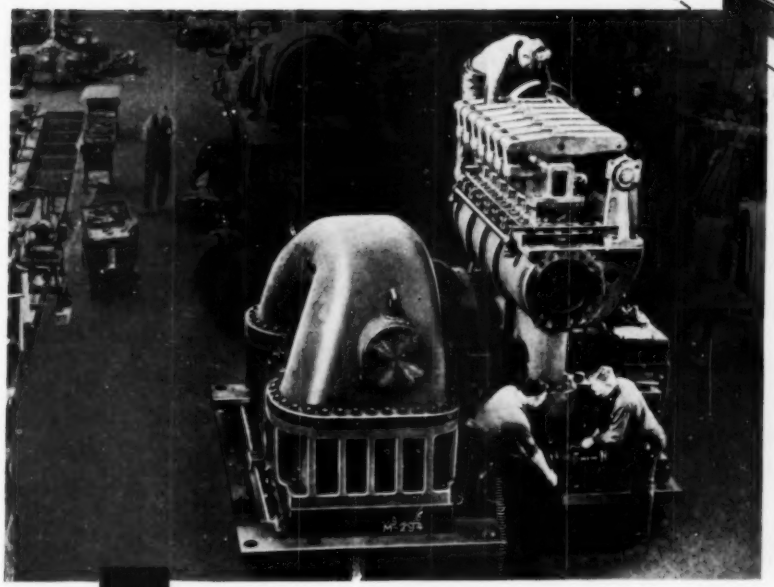
More than 400 guests of Eutectic Welding Alloys Corporation attended the formal opening of the company's new plant in Flushing, N. Y., October 7. Professor Otto H. Henry of Polytechnic Institute of Brooklyn was guest speaker and Rene D. Wasserman, president and founder of Eutectic Welding Alloys Corporation, described the company's eight-year research and development program.

Guests were shown the laboratories, foundry, chemical division, Eutecto film section and the giant high speed extrusion presses of the company's design. Also reviewed was the company's train-

Compact, sturdy, dependable. A Worthington single-stage, centrifugal compressor-drive turbine.



FROM SMALLEST SINGLE-STAGE TO MULTI-STAGE GIANTS



A standout for size. One of two Worthington 24,000 hp centrifugal compressor-drive turbines during assembly.

Worthington Turbines Meet the Broadest Range of Drive Requirements

Worthington Turbines offer you unlimited choice of sizes and types — including straight condensing, straight non-condensing, extraction, mixed pressure extraction, low pressure and high back pressure. Steam or gas driven, for mechanical or generator drive, all are available with governors for constant or variable speed, with optional governor-control.

LOWER-COST BLOWER AND COMPRESSOR OPERATION

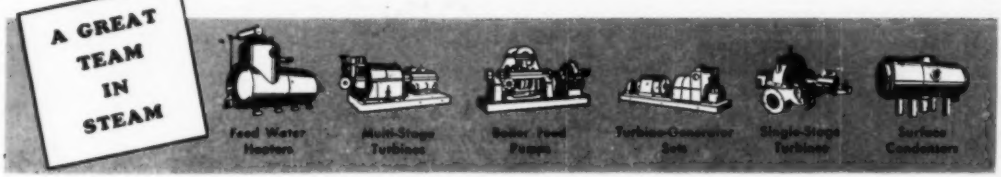
In the complete Worthington line you'll find the *right* speeds and horsepowers to keep your blowers, compressors and other mechanical drives operating at peak efficiency. And since each Worthington Turbine — from the smallest to the largest — is designed to make steam do more work, you can count on steady power- and money-saving throughout a long, trouble-free service life.

Get the whole story of this economical, always dependable power from your nearest Worthington representative. Or for further facts proving *there's more worth in Worthington*, write to *Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, N. Y.*

WORTHINGTON

STEAM TURBINES

T9-5



No matter how gooey the stuff, it can't "gum up the works" in a Sier-Bath Screw Pump. The powerful thrust of its screw moves materials so viscous that they are often in a semi-solid condition.

The simple design (only two moving parts) and accurate but sturdy construction, make these screw pumps long-lived and keep them relatively free of maintenance. They are available in horizontal and vertical models. Send for booklet.

ALSO MANUFACTURERS OF SIER-BATH GEAREX ROTARY PUMPS AND SIER-BATH PRECISION GEARS

FOUNDED 1905 MEMBER A.G.M.A.

Sier-Bath
GEAR and PUMP CO., Inc.

9249 HUDSON BLVD., NORTH BERGEN, N J

ing school, the Eutectic Welding Institute. Welding booths were in actual operation to demonstrate the unique surface-alloying properties of five of the company's arc and torch rods.

Stone

Krieger

Chemsteel Executives

Arthur M. Krieger has been named president and general manager and Charles E. Stone, secretary-treasurer of Chemsteel Construction Company, Inc.'s new associated company, Affiliated Furnace & Engineering Inc., which will specialize in design, construction and maintenance of industrial furnaces. Other officers include Clarence B. Avery, vice president, engineering; and Merrill A. Stewart, vice president, construction.

Krieger, who was former manager of the Estate Heatrola Division of Noma Electric Corporation, was previously associated with Universal Atlas Cement and Carnegie-Illinois Steel Corporation in the construction, maintenance and operating divisions. Stone was formerly general sales manager of Atlas Mineral Products.

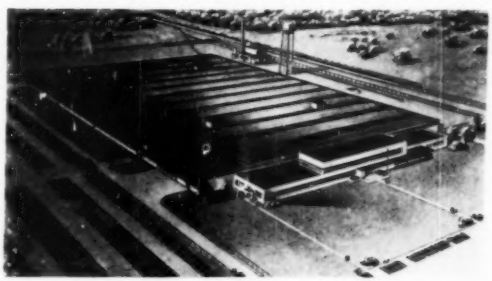
Graver Announces Expansion Of Water Conditioning Unit

Graver Tank & Mfg. Co., Inc., has announced the establishment of the Graver Water Conditioning Company as a division of the company to extend the operations which have been conducted by the Graver Water Conditioning and Process Equipment Department.

Graver has been engaged in the water conditioning field for 40 years, and the expansion of the staff and facilities which accompanies this development enables the company to provide "individualized and complete technical, chemical, engineering, manufacturing and erection services for all water treatment and liquid conditioning requirements."

Clark Opens New Factory

Clark Equipment Company has completed a new factory at Jackson, Mich., which represents the major undertaking in the company's overall expansion program. The plant, which was formally opened September 24 at a "Family Day" house warming attended by the company's Jackson division employes and their families, will combine production of the company's line of transmissions, gears and forgings. The company also operates plants at Buchanan, Battle Creek and Berrien Springs, Mich.



Southern Engine and Pump Named Ampco Distributor

Southern Engine and Pump Company have been appointed exclusive distributor for the line of aluminum bronze pumps manufactured by Ampco Metals, Inc., of Milwaukee. The pumps are of special design for the pumping of process acids, salts, alkalies, and other corrosive or erosive liquids. Southern Engine and Pump Company will store these pumps in their branches at Houston, Dallas, San Antonio, Kilgore and Edinburg. Maintenance and repair services will be available from each branch.

Yarway Personnel Changes

Yarnall-Waring Company, Philadelphia, has announced the following appointments in its sales organization: John A. Steer, formerly district manager of Philadelphia territory, appointed New York district manager, succeeding Harold S. Webster, who has retired; and J. B. Ambler, appointed sales representative in the Denver district.

Other additions have been made in the company's list of steam trap distributors.

National Aluminate Forms New Catalyst Division

A partial reorganization plan of National Aluminate Corporation, Chicago, has resulted in the formation of the Catalyst Division, with Gage Averill serving as the new sales manager. Previously Averill was with American Cyanamid Company as supervisor of sales, Petroleum Chemicals Department. Production manager for the catalyst plant will be Dr. D. G. Braithwaite, formerly assistant director of research for National Aluminate Corporation. Dr. Braithwaite has been engaged in Nalco's research and development work on catalysts for the last several years.

Averill

The formation of this new division "seeks to insure the best possible service to the refining industry by separating the sales and production of

catalyst from the other activities of the corporation." Production of a fluid type petroleum cracking catalyst is already under way in the corporation's plant No. 2 in Chicago.

Naujoks Joins Ladish

Waldemar (Wally) Naujoks, authority on drop forging techniques and author of the "Forging Handbook," recently joined Ladish Company, Cudahy, Wis., as special projects engineer. He will devote his attention to problems embracing the development of ferrous and non-ferrous alloy forgings.

Naujoks

A member of the American Society of Mechanical Engineers, the Cleveland Engineering Society and the Army Ordnance Association, Naujoks is a graduate from the University of Wisconsin, and has degrees in engineering and metallurgy.

Naujoks has spent many years in the hot metal-working field and has been notably active in writing and lecturing on forging subjects. His background, therefore, "presents a combination of broad, practical shop experience and outstanding scholastic achievements."

De Laval Sales Staff Changes

A new Tulsa office has been opened by De Laval Steam Turbine Company, with Harold Meyer as manager. Meyer has been handling the sale of De Laval pumps, turbines, blowers and gears for over six years and has had experience in the application of the company's products in many branches of industry.

Meyer

Recently appointed representatives for the company are Lefler Wymont Supply Company, Casper, Wyo., for the states of Wyoming and Montana, and Roger Brown Company, El Paso, for southern New Mexico and the southwest corner of Texas.

PETROLEUM REFINER CLASSIFIED ADS

RATES for Classified Ads are $8 per column inch. Minimum size one column inch. In smallest type size, figure 50 words per inch. Situations Wanted $4 per column inch. **All classified ads payable in advance.** Ten percent discount if three or more insertions are ordered at same time. COPY DEADLINE is 25th of month preceding date of issue. Send copy and checks to: Classified Ad Department, Petroleum Refiner, P. O. Box 2608, Houston 1, Texas.

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SALES—PROFITS

Established Los Angeles-San Francisco organization of professional sales engineers selling top lines of equipment can handle additional accounts. Centrally located offices with service and warehouse facilities. Coverage includes refinery, chemical, power, aviation, and municipal sales. Write Box 161-R, c/o Petroleum Refiner, Houston, Texas.

We Have to Offer:

Thirty years of successful selling in Western New York, Pennsylvania, Ohio, West Virginia and Kentucky; all experienced and able personnel; technical knowledge and proven salesmanship; oil refinery, chemical plant and gas industry contacts. We are interested in representing company whose products are applicable to above industries. Address: Box 160R, c/o Petroleum Refiner, Houston, Texas.

WANTED

An American oil company, operating in South America, is in need of oil refinery utilities shift foremen. Would be required to supervise operation of a steam generating plant, diesel engine generating plant, power distribution facilities, water systems, distillation plant, refrigeration equipment, and fire fighting facilities.

Write, giving age, marital status, education and a detailed experience resume. Your letter will be held strictly confidential.

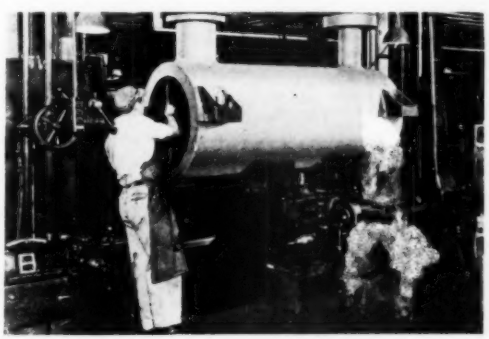
Box 308-U, Radio City Station
New York 19, New York

Chicago Metal Hose Makes Four Sales Staff Changes

Chicago Metal Hose Corporation has announced sales department organizational changes as follows: Shelby A. McMillion appointed assistant to A. S. Keller, vice president in charge of sales; T. K. Wells, formerly regional sales manager, bellows division, appointed assistant to the vice president in charge of sales; E. L. Hiter, formerly district sales manager at the New York office, appointed manager of sales for the Eastern division which has sales offices at Boston, New York, Philadelphia, Pittsburgh and Atlanta; A. W. McGuire, formerly regional sales manager, expansion joint division, appointed manager of sales for the Western division which includes sales offices at Detroit, Cleveland, St. Louis, Fort Worth, Glendale, San Francisco and Chicago.

Four Industrial Salesmen Added to Taylor Staff

Taylor Instrument Companies have announced the placement of four new salesmen, two of them in the Tulsa territory, one in St. Louis and one in Chicago. Damon C. Ralph, stationed in Freeport, La., is a graduate of Oklahoma A. & M. with a degree in industrial engineering, and was business editor of the Oklahoma State Engineering magazine before his recent appointment. Donald F. Sullins, also a graduate of Oklahoma A. & M. in industrial engineering, will cover the northwest section of Texas. Located in Omaha, Neb., will be Charles H. Miller, former secretary of Insulation and Refractories Company, Williamson, N. Y., and a graduate of the University of Rochester. William Hile, who has been with the company for several years as a member of the application engineering department, is a mechanical engineer from Purdue University. His territory will be the state of Indiana.



This photo, taken at Pacific Pumps, Inc. Huntington Park plant, shows one of five Type I cast steel pump cases with 6-inch walls now being built for boiler-feed service for one customer. Each 8-inch, 10-stage unit will handle 800,000 pounds per hour of 343° F. feed water with a 2430 psi discharge at a speed of 3550 rpm. The units will be powered by 3125-h.p. motors.

Hammel-Dahl Dealer Named

Horace A. Thompson Jr. has been appointed equipment dealer for Hammel-Dahl Company, Providence, R. I., manufacturers of automatic control valves. Thompson is specializing in chemical and petroleum processing instruments. A graduate of Tulane University in 1938, he majored in chemical engineering and was associated with Esso Standard Oil Company until 1941, when he joined the Marine Corps. In 1945, he formed Thompson Equipment Company of New Orleans which represents Hammel-Dahl Company in central and eastern Louisiana, southern Mississippi and northwestern Florida.

Thompson

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in the December, 1949, issue of

Petroleum Refiner

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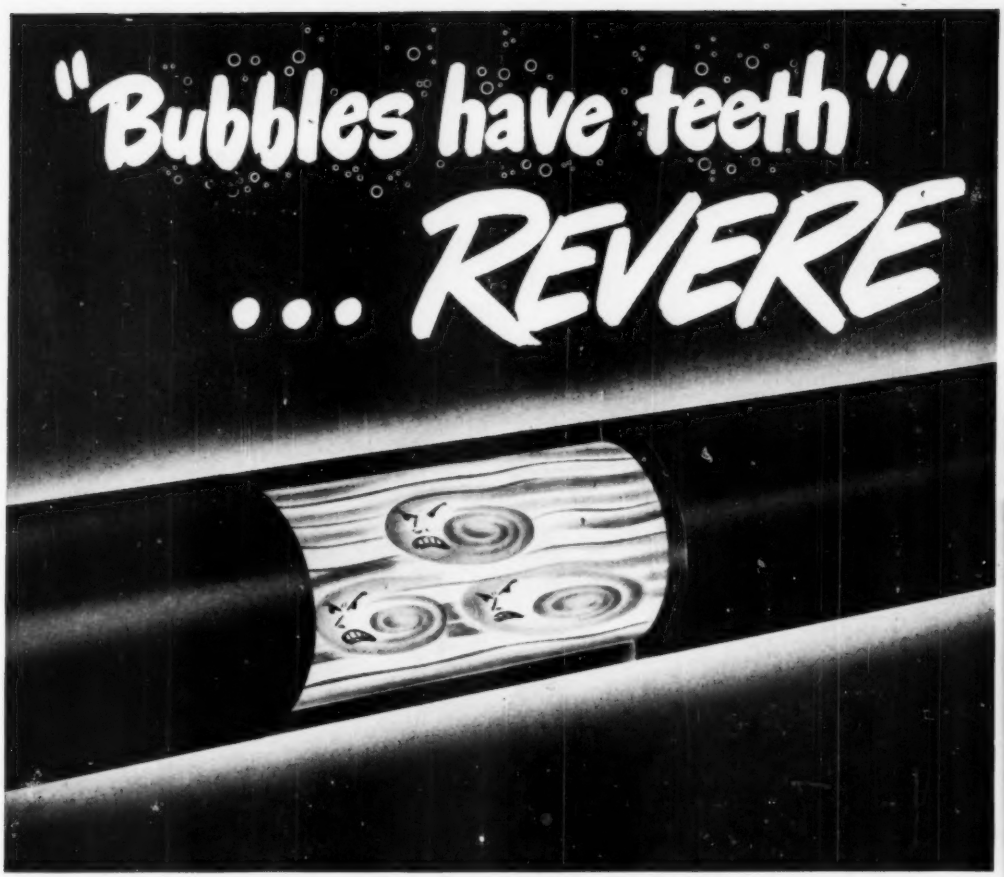


SOME years ago Revere said that "Bubbles have teeth." It is still true. Air bubbles in a condenser can eat away at the tubes quite rapidly, and become a cause of failure with consequent re-tubing. Air-entrainment, as it is called, acts in several ways, all destructive to tubes. Air contains oxygen, which directly attacks most metals, forming oxides. Carbon dioxide in solution dissolves these oxides. That is not all. Air bubbles add to the erosion effect of turbulent flow. The higher the velocity, the worse the effect, and the more swift and serious is the combination of erosion and corrosion at points of greatest disturbance. Every effort should be made therefore to keep air from being carried into the cooling water. If you are troubled by frequent re-tubing of your condenser, get in touch with Revere, but first save a few samples from failed tubes for examination by our laboratories to determine the cause of failure. Many users of condenser tubes have found our collaboration exceedingly valuable, and we are always glad to cooperate in an effort to extend tube life.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.—Sales Offices in Principal Cities, Distributors Everywhere.

Accurately made to close tolerances
Uniform rib width
Ample lap widths
No cracks on outside corners
No wrinkles on inside corners

No Wrinkles... No Cracks... No Blowouts!

no place for leaks in THIS heat exchanger gasket

TAKE A CLOSE LOOK at the Goetze heat exchanger gasket shown above. Note the absence of cracks on outside corners . . . of wrinkles on inside corners . . . the uniform width of the ribs . . . the generous overlap of the metal jacket.

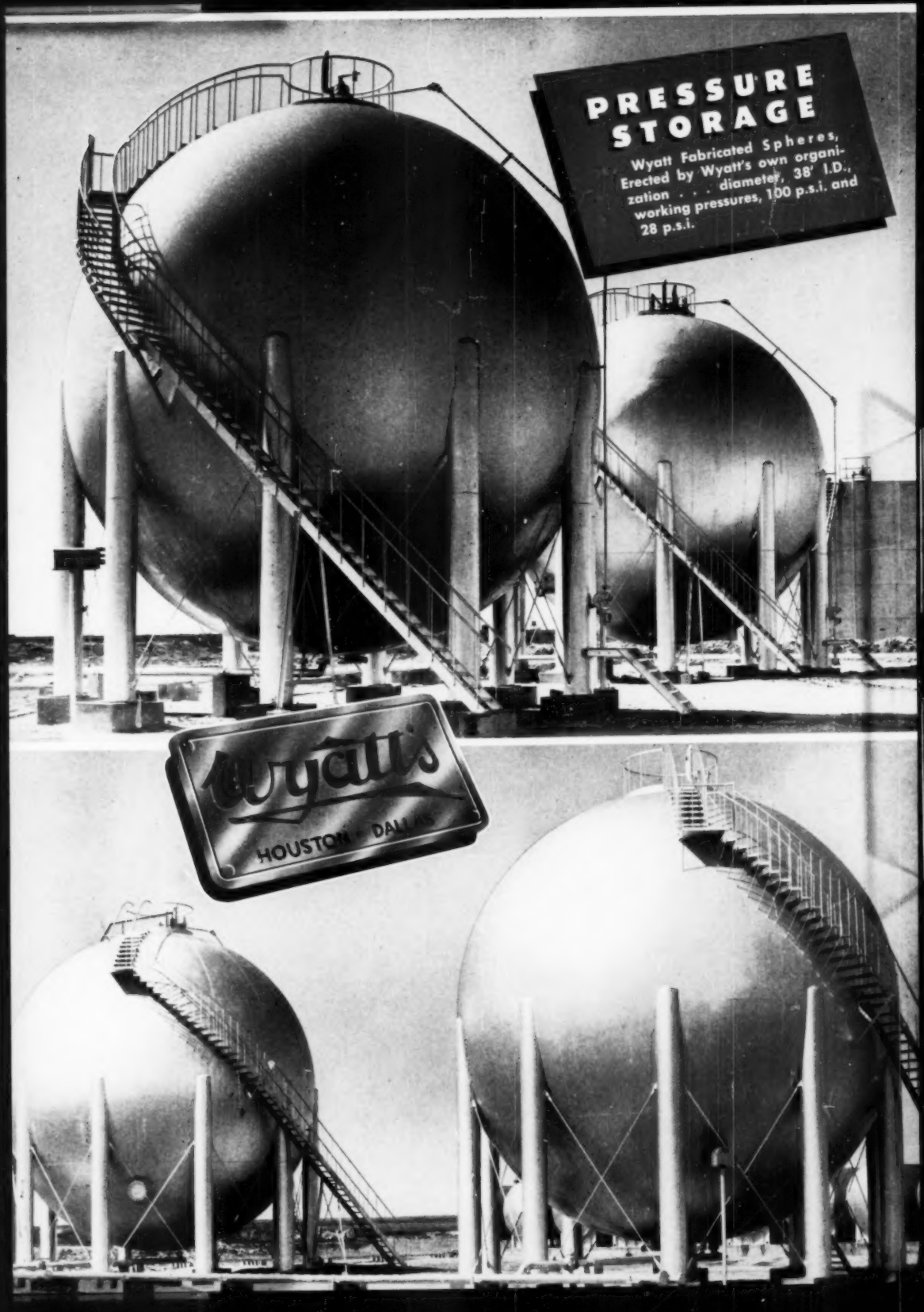
Attention to such important details is typical of the kind of care that goes into the forming of these custom-made gaskets. It is the secret of their dependable service—why you can count on them to stay on the job indefinitely without leaks or blowouts. And it's the reason they pay off in terms of less down-time and in the savings that result when gaskets *don't* have to be replaced at frequent intervals.

• • •

You can have Goetze heat exchanger gaskets made in any size or shape. Estimates and recommendations will be furnished promptly on request. Write Johns-Manville, Box 290, New York 16, N. Y.

JM PRODUCT

Johns-Manville *Goetze* Gaskets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Wyatt Fabricated Spheres, Erected by Wyatt's own organization . . . diameter, 38' I.D., working pressures, 100 p.s.i. and 28 p.s.i.
Wyatt's
HOUSTON - DALLAS

NEW

AVAILABLE FOR IMMEDIATE DELIVERY

LOA

Balanced Design, Special Feature

A DESIGN FOR TROUBLE FREE LOADING.

SWING JOINT FEATURES ARE EXACTLY THE SAME AS OUR WELL KNOWN MASTER SERIES — CONCENTRIC DESIGN.

RANGE—7 ft. closed to 11 ft. extended—measured from center line of riser.

DIVIDED COUNTER-WEIGHTS—cannot strike riser.

SOLDERLESS JOINTS on entire brass slide sleeve assembly —assures easy replacement and stronger construction.

BOLTED STUFFING BOX on slide sleeve—easily adjusted and repacked—oversize bearing area assures easy operation.

FELT WIPING GASKET—easily replaced—keeps slide tube clean—increases life of tube and packing.

McDO

in design
in effectiveness
in economy

McDONALD
OADING ARM ASSEMBLY
(Plate 214—Size 3")

tures, Bring New Efficiency to Loading

STOP CUSHION—no shock when tube is suddenly extended full length.

ALUMINUM OUTBOARD SWING JOINT—concentric design—drop tube hangs vertically.

DETACHABLE HANDLE—operates slide sleeve and drop tube.

SHOCK-PROOF LOADING LINE VALVE equipped with effective VACUUM BREAKER.

Write for prices and further details of the new McDonald Loading Arm Assembly.

A. Y. McDONALD MFG. CO.
The Home of the Swing Joint
DUBUQUE, IOWA
There's a McDonald Branch or Distributor Near You

ONALD